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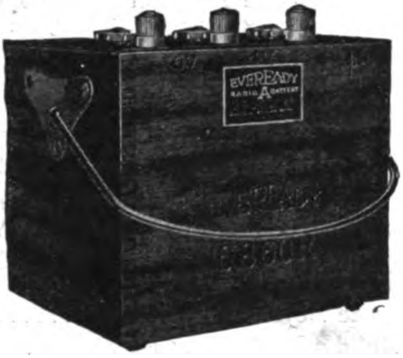

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* **LAURENCE M. COCKADAY, R.E.,** *Technical Editor*

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A PAGE WITH THE EDITOR

Another Popular Radio article has stirred up a tempest in a teapot—or, to be exact, in a kettle. When Houdini wrote his now famous article, "Ghosts that Talk—by Radio" (published in our October issue), he told how certain fake spiritualist mediums had been using inductive radio for years in performing tricks credited to spiritualistic phenomena. He mentioned, among other devices, a "talking kettle," invented by David P. Abbott. In conformity to the ethics of his profession, Houdini did *not* reveal the secret of the kettle.

* * *

The Editor must take upon himself the full responsibility of explaining the *modus operandi* of the kettle in the form of diagrams and footnotes prepared in the sanctum—and it was just this specific detail that stirred up the unexpected tempest. Following the storm, we are glad to report that Houdini has been entirely exonerated, even if the purposes to which the talking kettle have been applied is still a live topic of discussion.

* * *

In the meantime, however, Popular Radio's explanation of how inductive radio is used for performing such tricks is technically correct, as every radio expert knows.

* * *

"I have read all kinds of radio magazines," confesses Frank J. Sloane, of Toronto, Can., "but none can compare with Popular Radio." The immediate cause of this reader's enthusiasm is a hook-up which appeared in our May issue, with which Mr. Sloane experimented. Among the many stations he picked up with it were WNAS, WOH, KYW, WHD, WHAM, WGL, WWI, KSD, WJZ, WGI, WHAS, WOB, 2XE, CJGG and CKAC, covering a territory from Manitoba to Kentucky, from Massachusetts to Iowa, and including a score of States!

If you see it in Popular Radio, *it's so!*

* * *

Here's an idea that is worth recording; it comes from Edward J. McDonald of Alton, Pa.: "Popular Radio is the best radio magazine on the market. I am binding the last few issues in book form for reference; it makes a fine hand-book on radio. Please keep your magazine at its present dimensions."

We will—only we *must* add more pages!

* * *

That (happily) rare bird who delights in "writing to the papers" but who hides his shrinking soul behind letters that bear neither name nor address, is advised to save his efforts so far as Popular Radio is concerned. We carefully file all anonymous contributions where they belong—in the scrap basket.

* * *

An army sergeant in Grove City, Pennsylvania, recently addressed a letter to "*the* radio magazine." Naturally, it was properly delivered to Popular Radio.

* * *

Still another scientist of international fame has been added to the rapidly enlarging list of distinguished contributors to this magazine. The newest Popular Radio author is Prof. J. A. Fleming, F. R. S., known throughout the world as the inventor of the "Fleming valve"—the first vacuum tube ever used in radio.

"There's a reason" why the foremost scientists of the world select this magazine as the medium of expression—and that reason is so apparent that the Editor will modestly refrain from comment.

* * *

So popular is our department, "What Readers Ask," that our Technical Editor is literally deluged with inquiries from radio fans throughout the country. Indeed, the success of his department, gratifying as it is, is causing real embarrassment to him, as it is impossible for him to answer his letters as fast as they pour in. At last reports he was eleven weeks behind in his correspondence and sinking fast!

* * *

To meet the situation Popular Radio, in justice to its subscribers, must hereafter restrict this special service to those fans whose names appear on its *subscription list.*

To those who are *not* subscribers a nominal charge of 50 cents will be made for each inquiry, to cover the cost of this service.

Beginning December 15th, accordingly, all inquiries of a technical nature addressed to our Technical Editor should be accompanied either by 50 cents service fee or by a subscription for a year—unless, of course, the correspondent is already a subscriber.

* * *

In our October number the Editor asked advice as to whether or not he should enlarge the magazine in order to permit its readers to profit from the rich supply of new and timely editorial material that is piling in upon us.

The response was an impressive "Yes." Eighty percent of the replies were, in effect: "*We want more* Popular Radio!"

* * *

The Editor gracefully yields to this expression of opinion. Beginning with our next number—February—Popular Radio will be substantially enlarged, although the price will be advanced only a nickel.

But our readers will get a larger and better magazine for 20 cents than they are now getting for 15 cents.

Kendall Banning

Editor, Popular Radio

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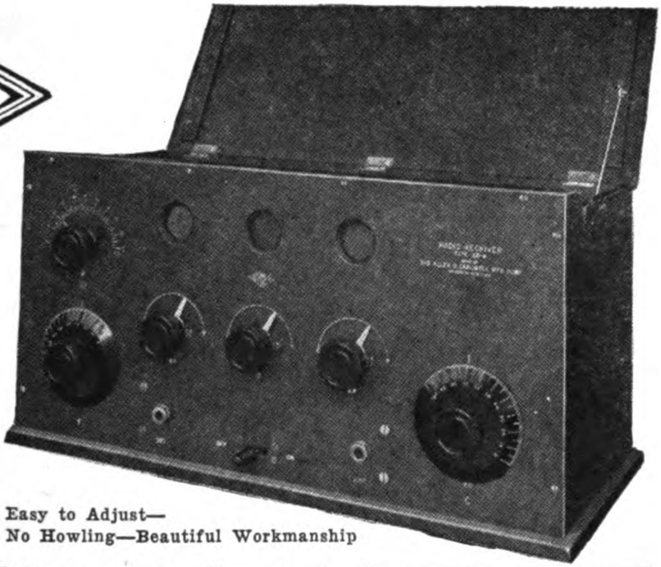

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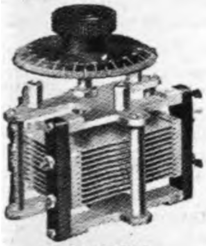

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WRITE FOR COMPLETE CATALOGUE

The Allen D. Cardwell Manufacturing Corporation

81 PROSPECT STREET BROOKLYN, N. Y.

From a photograph made for POPULAR RADIO

THE EVIDENCE OF EXPERTS

Into this scrapbook have been collected photographic copies of over a hundred letters from the country's foremost radio experts, dealers and manufacturers, endorsing POPULAR RADIO's *campaign to establish broadcasting upon the high plane that it must attain as a public utility. This book has been delivered personally into the hands of the Secretary of Commerce by Paul Godley (at the left) as evidence that the radio interests are not only ready for action but are demanding it.*

DO YOU WANT

BETTER BROADCASTING?

Will *YOU* Mr. Radio Fan, Mr. Dealer and Mr. Manufacturer, Help Get It? POPULAR RADIO Here Points Out the First Step for You to Take.

THE average fan's interest in radio is determined by the quality of the broadcast programs he hears. If he enjoys the entertainment, that enjoyment is reflected in the radio apparatus made and sold throughout the country.

Thus the problem of maintaining broadcast programs of the highest possible plane of interest becomes the most vital problem confronting the radio industry; indeed, the very existence of thousands of makers and sellers of radio equipment is hanging upon it *this month.*

Several months ago POPULAR RADIO began an investigation of the fundamental cause of the decline of public interest in radio. The cause was evident from the first; it was a general lowering of the standards of the programs —for reasons quite outside of the control of the broadcasting stations.

To assist actively in the establishment of high-grade programs, and to prove what could be done by actual demonstration, POPULAR RADIO initiated the following important projects:

The broadcasting of a series of outdoor concerts by the New York Philharmonic Orchestra last summer, through WJZ;

The broadcasting of side-line reports of the big football games in New York last fall, through WJZ;

The broadcasting of a series of indoor educational concerts by the New York Philharmonic Orchestra during the present season, through WEAF;

The installation of wiring in Cooper Union, New York, for the purpose of broadcasting lectures, concerts, conventions and other features of importance and value;

The broadcasting of a series of indoor concerts during the present season, 1922-23, by the City Symphony Orchestra of New York, through WJZ.

That these projects have stimulated interest in radio has been shown by the corresponding betterment in local radio trade. But, more im-

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From the most humble home to the elaborate drawing room, Crosley Instruments are preferred. Regardless of the many higher priced instruments on the market, the man who knows—even if he can afford to pay more—will choose Crosley.

There is no secret in this. Crosley instruments are the acme of efficiency and simplicity and their construction is based on sound fundamental principles. Numerous tests by disinterested parties all over the country will bear us out in this statement.

Your dealer should be able to furnish you with Crosley Apparatus. If not, send us his name and order direct.

If you are a Jobber or Dealer and do not already handle Crosley Instruments, you will be wise to satisfy the demand that our national advertising has created.

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RADIO

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CROSLEY RECEIVER MODEL X. A four-tube outfit the same as shown in the above scene. It consists of tuner, one stage of Tuned Radio Frequency Amplification (the feature that has made this set so popular) Detector and two stages of Audio Frequency Amplification in a beautiful mahogany cabinet. It will bring in distant stations loud and clear. With this set, listeners in Florida have heard Winnipeg, San Francisco and Honolulu. Price, without phones, batteries or tubes, $55.00.

portant than merely offering temporary stimulant to the industry is the problem of establishing these high-grade programs upon an enduring and sound economic foundation—of insuring the best possible entertainment for the longest period of time, with the least possible interference, and at a proper cost that should be paid by the proper interests.

The first step in the attainment of this object is to establish the proper legal authority in Washington for dealing with the present emergency.

In the opinion of those who best know the situation, the establishment of the necessary governmental authority may best be attained by passing the pending radio bill (known as H. R. 11964), proposed by Congressman White of Maine on June 9, 1922. Since that date the bill has lain dormant, largely because the law makers felt uncertain whether or not the radio interests were ready to push it.

In order to gauge the present temper of the radio industry toward the need of immediate action, POPULAR RADIO sent to a thousand leading dealers and manufacturers of radio apparatus a letter accompanied by a galley proof of an editorial that was published (in part) in our December number. That editorial outlined a constructive project for meeting the present situation.

The response to this letter was electric. It gives impressive proof that the industry is ready for action. It gives convincing evidence that the time has come to push House Bill 11964 *and to get it passed,* either in its present form or with such changes as may be decided upon when it comes up for consideration at the hearings.

The passage of this bill, consequently, directly concerns not merely every radio dealer. It concerns *every radio fan in the country.*

In proof of this attitude of the industry, POPULAR RADIO has selected the first hundred letters that came in from the more important dealers and manufacturers, made photographic reproductions of them, mounted them in an album and sent the album down to our lawmakers in Washington, as tangible evidence that the time for action has come. And to insure its attention by the proper officials, the evidence has been sent in the custody of a fan who needs no introduction, either to the radio amateurs or to the authorities in Washington—Paul Godley.

The readers of POPULAR RADIO—the fans, the novices, the amateurs, the dealers, the manufacturers—can render no more useful service at this time than to urge upon their Congressmen and upon their Senators to have this bill brought up for consideration at the present session of Congress.

POPULAR RADIO does not believe that the radio bill is perfect in its present form. It believes that certain changes are desirable. In all probability these changes will be made when the bill is under consideration. And the only way to bring these points to an issue is to *urge action now.*

The bill, originally drawn at the suggestion of Secretary Hoover, has been endorsed, at a conference in Washington last spring, by a thoroughly representative body of men, representing the foremost radio amateurs, scientists, engineers and manufacturers. It provides for the establishment of an agency (the Department of Commerce) that shall be charged with the responsibility of getting radio on the right track and of keeping it there. By way of guiding this agency, a committee of twelve men is also provided for, each of these men to be chosen from one of the departments of the government and six from among radio engineers of standing. Amateur station owners are taken care of through the allotment of all waves between 150 and 275 meters to their use under certain proper circumstances. The Secretary of Commerce is given power to stipulate what wavelengths are to be used for the various classes of radio services; to say how these services shall be conducted; to stipulate the nature of broadcasting programs, and to specify the time of operation of broadcasting stations, and the power to be used; to penalize station owners who do not play the game; and to make changes in regulations as they become necessary.

In brief, the bill establishes the necessary authority for handling the situation that now confronts the radio interests; it does not, however, affect the government radio stations. The President assigns the wavelengths for them.

Unless this bill is acted upon during the present session, it cannot be acted upon for another year—in which case the radio fan cannot profit from it until 1924.

This magazine believes that action on this bill —action that will result in its passage in either its present form or with such revisions as may be decided upon—is of immediate importance to the radio interests. The last radio legislation was passed by Congress in 1912, and is inadequate to meet present day conditions.

POPULAR RADIO, accordingly, advises each of its readers to send both to his Congressman and to his Senator, some such letter, telegram or postal as this:

"I favor the radio bill, H. R. 11964."

And as every day counts, POPULAR RADIO advises its readers to send this brief message *today!*

Send this message to your Congressman and to your Senator at Washington. Do it *now!*

"I favor the radio bill, H. R. 11964"

(SIGNED) *John Doe*

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IT was in 1913 that the Magnavox electro-dynamic receiver made its first public demonstration, when telephone communication was held by means of it between Denver and New York—a revolutionary advance.

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Manufacturers of Complete Radio Sets and Parts
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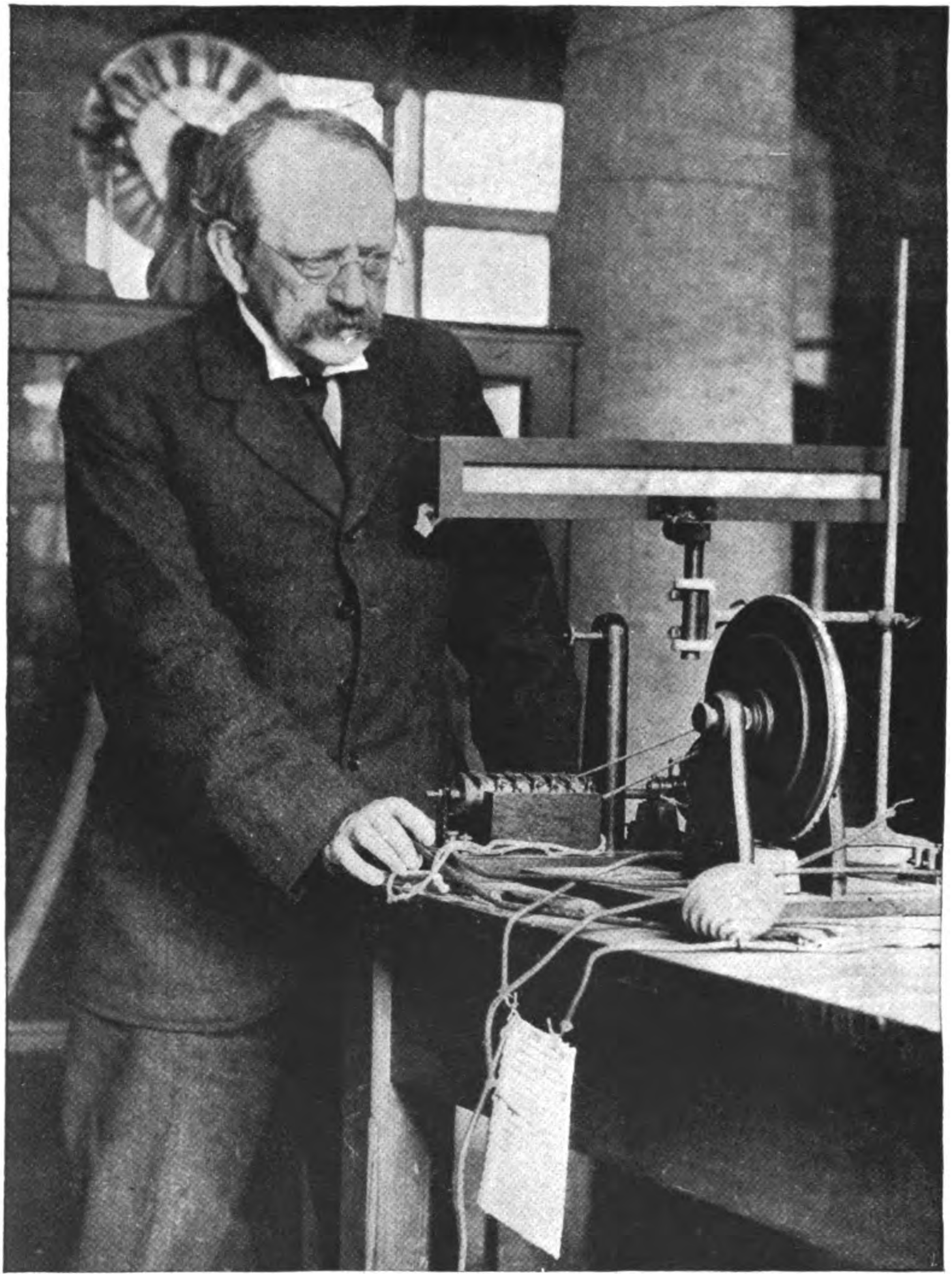
"All thinking men must realize that in the broadcasting service we have a potentiality, particularly for education and culture, the like of which the world has never known in its history. We must find a practical way to utilize this great potentiality for the maximum good to all of our people."

George O. Squier

MAJOR GENERAL, UNITED STATES ARMY



From a photograph made for POPULAR RADIO by the Special Press, London

HE PROVED THAT THE ELECTRON REALLY EXISTED

Not until the distinguished English physicist, Sir J. J. Thompson, demonstrated by actual experiment that the electron was not merely a theoretical but an actual physical body was the "electron theory" finally accepted by the world of science. He is here shown in his laboratory at Cambridge, explaining the phenomena of electricity and magnetism in terms of the theory which his research work validated.

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Popular Radio

VOLUME III JANUARY, 1923 NUMBER 1

What Bends Radio Waves?

"Ground Conduction," answers Dr. Elihu Thomson. "The Heaviside Layer," believes Sir Oliver Lodge—for reasons which he specifies in this article.

THE ARGUMENT IN A NUTSHELL:

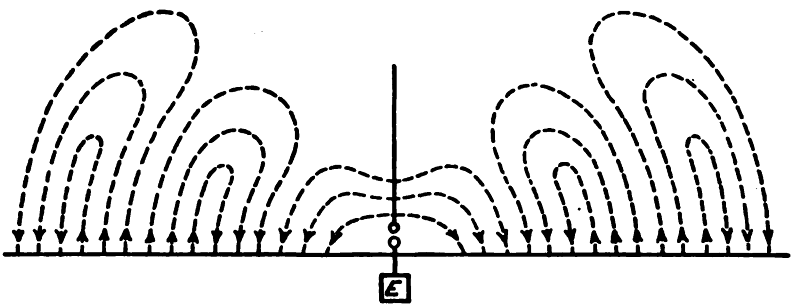
Until radio signals were transmitted across the ocean in 1896 scientists believed that radio energy followed the laws of wave motion and traveled in straight lines. Following that disturbing event, however, scientists were required to offer another explanation of radio phenomena. So they evolved the "Heaviside layer" theory, which presupposes a conducting layer of gas that envelops the earth and that bends the radio waves around the earth's surface. This explanation was generally accepted until Dr. Elihu Thomson, the distinguished American scientist, rejected the Heaviside layer theory (see POPULAR RADIO for December, 1922) and submitted instead the theory that radio waves are conducted across the ocean by earth-conduction. In the following article the foremost English authority on ether answers Dr. Thomson and makes a vigorous defense of the generally accepted layer hypothesis.—EDITOR.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

IN the early days of Hertz waves, 1888 to 1894, when we were engaged in demonstrating the reality of electrical oscillations in the ether (that is in free space) we avoided earth transmission as being unfair and deceptive, suggesting the conclusion that the disturbance was being transmitted by the conducting power of the earth rather than by the insulating power of the ether.

Thus, for instance, if a Hertz oscillator or a discharging Leyden jar was attached to the gas pipes of a building it was easy enough to get disturbances in neighboring buildings and to light the gas at a distant jet bv turning it on and bringing a finger or piece of metal near it. But it was possible also and more interesting to get sparks in unexpected places, as for instance between gas and water taps which happened to be near each other in a basement, when the discharge circuit of a condenser was completely insulated in a room above—which is indeed a modification of the experiment that Joseph Henry conducted at Washington, D. C., long ago, though at that date he did not know the meaning of it.

So long, therefore, as we were experimenting with wireless waves mainly for theoretical and, so to speak, optical purposes, verifying Clerk Maxwell's theory



HOW RADIO WAVES RADIATE FROM A GROUNDED OSCILLATOR
Notice that the transmitted waves are half-waves only; in scientific terms they are "dichotomized."

of light—reflecting, refracting, and polarizing the waves by suitable apparatus, and seeing how far and by what means they could enter closed spaces—it was natural and proper to have the main oscillator insulated from the earth and avoid anything that could be suspected in the direction of earth conduction.

But when Marconi, in 1896 and onwards, applied these waves to practical telegraphy, his object was to get the signals at a distance, no matter by what means they went. He therefore naturally and properly employed earth conduction for all it was worth, making a good earth-connection at both sending and receiving stations, so that the earth became part of the oscillator. Thus began the Marconi aerial and ground system, which, as we all know, is very effective for long-distance work.

We were all fully aware that the effect of this system would be to dichotomize the waves or cut them in half (which had been depicted diagrammatically by Heinrich Hertz) and to assist them to run along the surface of the ground so far as it was conducting. It was natural, therefore, to expect and to get better results over sea than over land.

So also if we wanted to get signals from a coherer inside a closed metallic chamber, we found we could do it by allowing some metallic conductor to enter that chamber, provided it was insulated from the chamber at its place of entry. The entry of a gas pipe, for instance, into a metal coated room, had the virtual effect of turning the room inside out and of thus eliminating its screening property; though, without such introduced conductor, a metallic enclosure was a complete shield against ether waves. But we found that the merest chink, or even a bad joint in the metal coating of a chamber, allowed some of the waves to penetrate; though a round hole was not equally effective, unless a bit of gutta-percha-covered wire was put through the hole to act as a sort of speaking tube or conveyer of the waves into the interior.

We also suspected that any stray conductors, like wire fences or buried mineral lodes or any other conducting material, would help to transmit the waves. And Dr. Alexander Muirhead applied to a cable company for permission to make connection with the outer metallic sheathing of a cable, in order to see whether the signals could not thus be transmitted with greater ease. But the dislike of any responsible cable company to the idea of high voltages applied to any part of their cable prevented this experiment, and good earth connection was found sufficient without it.

That metallic conductors conveyed the waves was, however, well known, and I first obtained evidence of the existence of such waves along wires, by reflecting them so as to get nodes and loops, early in 1888 and even before the publication of Hertz's great discovery of their ready transmission by free space.

From a photograph made for POPULAR RADIO

Experiments with the Hertz oscillator—shown above—prove that radio waves can be transmitted without using a ground.

How far earth conduction assisted, or would be likely to assist, the transmission of waves between a completely insulated transmitter to a completely insulated receiver became an open question, and at Messrs. Muirhead's works many experiments were made. What we found was that the avoidance of earth connection assisted the definiteness and purity of the waves, prolonging the oscillations and rendering very accurate tuning possible. We found, indeed, that earth connection spoilt the tuning by damping the waves, and we therefore preferred to use an aerial system consisting of two insulated capacity areas, one, called the antenna, elevated as high as practicable, and the other suspended at a fair height above the earth.[1] We found, indeed, that the best position for the lower capacity area or counterpoise was at such a height that the capacity of the whole was a minimum. If the counterpoise were put higher, it was brought too near the antenna. If it was put lower, it was brought too near the ground. We found a position at which the tuning was sharpest, and a record of these experiments was published by the Royal Society at a later date when they were fairly complete.[1]

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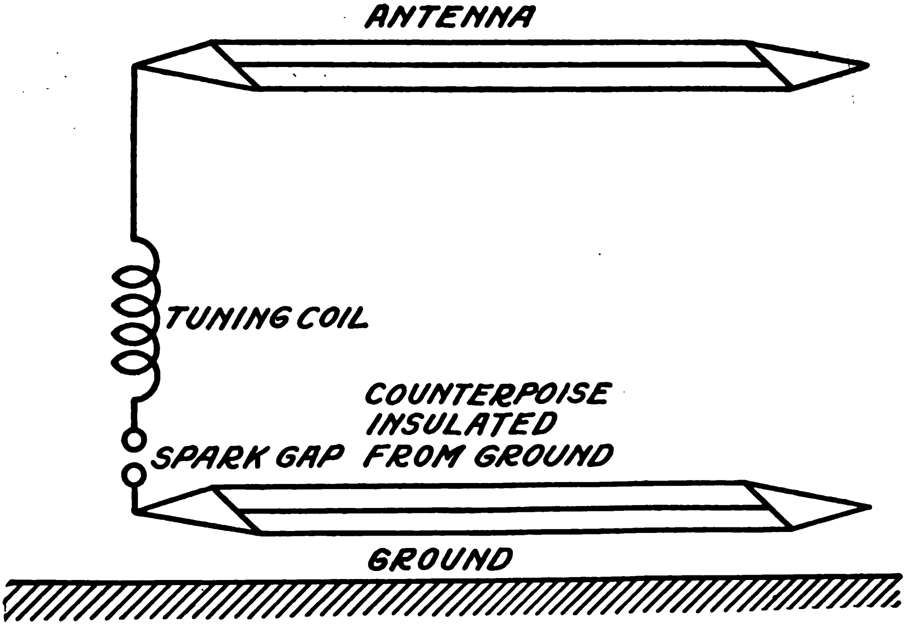
[1] *Known in America as a "counterpoise antenna."*

It was found, however, that for practical purposes the use of the earth as a ground was simpler in practice, and in some positions was inevitable; as, for instance, on board ship, where the sheathing of the ship made a perfect ground, and no other grounding was necessary. It was found also that the counterpoise or balancing capacity was always rather a nuisance and an expense, and that even if it was constructed it was best buried out of the way. It was found also that the extra damping, though in itself to a certain extent objectionable, was not so deleterious as might have been expected when a coil of considerable self-induction was employed, since the inductance of the circuit by prolonging the waves could partly overpower the damping effect of the ground.

The efficiency of the ground connection, however, might vary in different localities. Some soils constitute a very bad conductor, others a good one. And wherever sea-water is available there is no question but that it is desirable to use it. For whether earth conduction assisted every kind of wave, even from insulated aerials, there was no doubt that it would assist when the earth was made part of the oscillating system. The only objection to it was that it was indefinite and might have a high damping resistance. Even now it would be well to use a counterpoise for any experiments involving really precise tuning. But for ordinary purposes all that was necessary



NO GROUND IS NEEDED IN THIS TRANSMITTING SYSTEM

Every experienced amateur will recognize this oscillating system that includes, in addition to the antenna, a "counterpoise" between it and the earth. It permits exceptionally sharp tuning by cutting down the effective resistance of the circuit to a low value.

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[1] *See Proc. Roy. Soc., vol. 82, p. 227. 1908-9.*

was to get sufficient tuning and to reach the greatest distance possible.

The whole subject is summarized in Professor Fleming's treatise on *The Principles of Electrical Wave Telegraphy and Telephony,* Chapter VIII, in the second edition; probably in the first edition also. And the experiments of Zenneck on different kinds of earth—that is, on the effective different kinds of soil—is there quoted and elaborated, with a citation also of further experiments by Brylinski on page 743. The usual diagram of the dichotomized Hertzian waves is given on page 408 in Fleming's Chapter V, Section 11, where the earth is considered as a perfect conductor acting as a mirror to the upper capacity area, and as if the lower area were an equal distance below the surface. A similar discussion will be found in Prof. Pierce's *Principles of Wireless Telegraphy,* Chapter XV.

How far such a condition really obtains in practice must depend on the efficiency of the ground available; and the distortion which the waves inevitably undergo by traveling over poor conducting soil must be learned from the experiments of Zenneck and others above referred to.[1]

But in the November issue of this magazine Dr. Elihu Thomson claims that this earth transmission is the really effective way in which the waves are conveyed to great distances and are by this means enabled to go round the curvature of the earth and reach even the Antipodes. So he concludes that any upper conducting layer in the higher parts of the atmosphere is unnecessary to explain the transmission, and that the existence of such a reflecting layer has become a superstition.

It is difficult to decide this by experiment, for we cannot get away from the upper regions of the atmosphere and determine how effective the sea alone would

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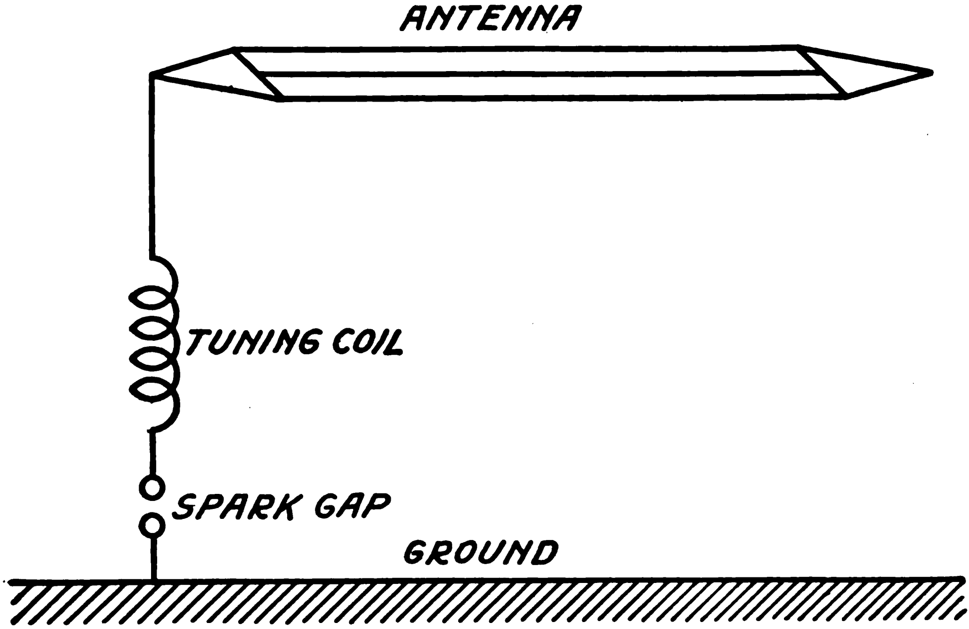
[1] *See, for instance page 736 in Section 14 of Fleming, Chapter VIII.*



BUT THIS MARCONI SYSTEM USES THE EARTH AS PART OF THE OSCILLATOR.
Why is it, then—if transmission depends upon earth conduction—that radio signals are so much stronger at night time than during the daytime?

From a photograph made for POPULAR RADIO

In this ungrounded receiver the earth plays no part in the reception of radio signals transmitted by the Hertz oscillator.

be without what has been called "the Heaviside layer" in the atmosphere. But it is plain that there must be a best conducting layer in the air, since the density of the air varies as you ascend from its ordinary value down to an absolute vacuum, and it is known that during the exhaustion of vacuum tubes, when the pressure is a few millimetres of mercury, the residual air does conduct to a degree almost comparable with the conducting power of water. It is further plain that if ether waves are confined between two strata, both fairly conducting, one above and one below, they will be kept from escaping in all directions and will spread out in only two dimensions, thus surely economizing their power.

It may be argued that the conducting layer in the upper air is too gradual to give sharp reflection—that is to say that the thickness of this layer is greater than any probable wavelength, and hence that the waves might succeed in penetrating it. I doubt that this is the contention. I believe that the contention of Dr. Elihu Thomson is rather that the layer is likely to be too irregular, too corrugated and uneven, to act as anything like a reasonably good mirror, even for long waves.

I should suppose that in the daytime, when the air is subject to all manner of vertical currents from the heat of the sun, such corrugations might very well occur, but that during the night, even if there were a wind below, the upper regions of the air with their high kinetic viscosity might be trusted to preserve a fairly even surface. And anyhow the demonstration by Marconi's large-scale experiments of the conspicuous influence of sunlight in spoiling transmission is not readily explicable unless the atmosphere has something to do with it. If transmission depends only on earth conduction—as Dr. Elihu Thomson seems to think—one would expect signals to be as good in the daytime as they are during the night.

Hence, on the whole, I think facts point to a real influence of the upper atmosphere on transmission; whether the part played by the atmosphere can be dissected out from the part played by the earth or sea may have to be settled by the mathematicians. And further, from different points of view, the opinions of high authorities in America and elsewhere may have to be ascertained before the question can be considered settled. I do not suppose that Dr. Elihu Thomson considers that he has settled the question, but rather that he has raised it in a more acute form and has reopened it in all its bearings for further discussion throughout the scientific world.

I have indicated sufficiently that I have nothing dogmatic to say about it, but I am impressed:

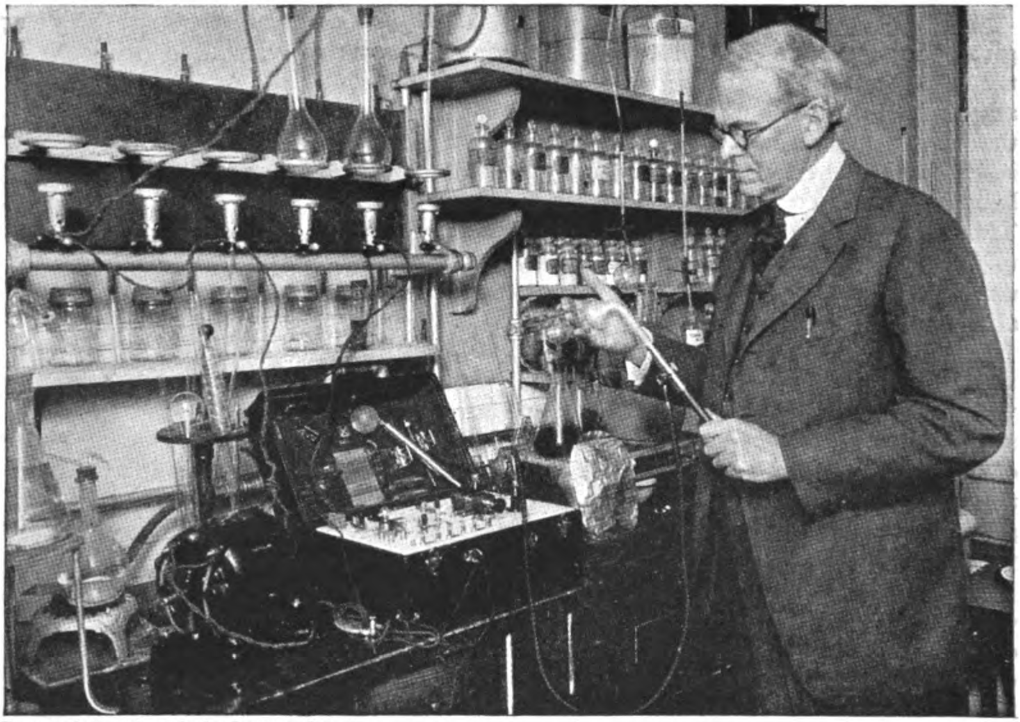
a. With the fact that a conducting layer in the upper air is inevitable.
b. That such a layer, if effective, would be a great assistance in very long-distance transmission.
c. That, without it, the deleterious influence of sunlight seems rather inexplicable.

Finally, Dr. Elihu Thomson writes as if there had been, in the past, undue scepticism concerning Marconi's great achievement of first getting wireless signals across the Atlantic. I know of no undue or improper scepticism about it. A hope was expressed by myself among others, in a congratulatory letter to the press, that further experience would confirm the result (as it conspicuously has), but caution in accepting a newspaper report of a remarkable achievement is not unprecedented, and hasty, enthusiastic congratulation on the strength of such reports has not always been justified.

Photo made for POPULAR RADIO

How the Navy Radio Experts Are Reducing "Interference"

No radio fan needs to be reminded of the days when the Navy's radio signals pretty much monopolized the ether. How this condition is being overcome—to the relief of the amateur—is told by Commander S. C. Hooper in POPULAR RADIO *for February.*



From a photograph made for POPULAR RADIO

RADIO ENTERS THE DOCTOR'S LABORATORY

Among the distinguished members of the medical profession who are experimenting with the application of radio to the study of the human being is the author of this article, Dr. Henry Smith Williams. Incidentally, he is the author of more than forty books on scientific subjects.

Photographing Our Emotions —by Radio

How Some of the Scientific Apparatus Developed by Radio Is Being Applied for Measuring the Physical Reactions of Thought

By HENRY SMITH WILLIAMS, M.D., LL.D.

WE read in the newspapers the other day about the girl who was entertained with a radio concert while a surgeon was operating on her with the use of a local anesthesia. The incident was sufficiently picturesque to catch the eyes of the reporters; and it suggests unexploited possibilities of radio-receiving in hospitals and other institutions, for diversional and even perhaps curative effects. But of course the case recorded had only incidental connection with medicine considered as a therapeutic art.

Another report, however, tells of a radio experiment that brings the new art a little more directly in coalition with the art of healing, a radio entertainment was given at the Central Islip Hospital for the Insane, near New York, under direction of Mr. Charles Isaacson; on which occasion about 3,000 patients listened to the opera "Cavelleria Rusticana," with explanatory comment, broadcast from the station WJZ at Newark, fifty miles away.

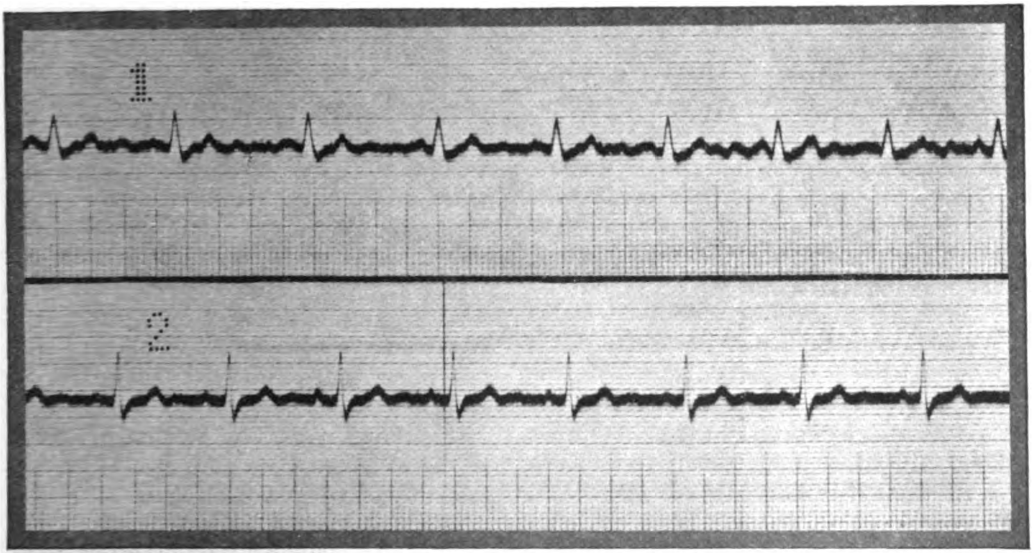
Mr. Isaacson, as is well known, has long been an enthusiastic advocate of the value of music in "ministering to the mind diseased," and his efforts to put his theories into practice have met with notable success. Hitherto he has been dependent upon musical performers who were present in the flesh at the institution, or upon phonograph records; now he has shown that radio may serve the purpose equally well, with the added advantage that one set of performers may entertain simultaneously an indefinite number of institution audiences.

The time is probably not distant when every public institution will be provided with radiophone receivers; and it is more than likely that in many places special programs, on isolated wavelengths, will be broadcast for the edification and mental benefit of institution residents. Even the prisons will probably be included in this program.

The therapeutic possibilities of radio thus utilized are by no means to be dismissed as trivial. Nothing revolutionary is to be expected in individual cases; but the aggregate betterment in mental outlook and what may be called "psychic morale," cannot fail to be consequential.

A more direct and tangible utilization of the radio principle, as regards individual patients, is that suggested by the experiments of Major-General Squier, in which the sound of the heart beat has been transmitted to a distance and magnified there by the use of triode amplifiers.*

This furnishes an interesting demonstration of the possibility of transmitting and magnifying sounds; something practical will doubtless come of it ultimately. But for the moment it does not directly aid the diagnostician, inasmuch as the heart sounds are adequately audible to the unaided ear, while the variations in



Courtesy of Dr. Louis Faugeres Bishop

AN ELECTRIC PORTRAIT OF ANXIETY

The upper "electrocardiogram" shows the cardiac current during a period when the patient experienced anxiety for the safety of her jewels, left in the dressing room. The lower electrocardiogram shows the heart current of the same patient a few minutes later, after mental equanimity had been restored. This is part of one electrocardiographic record excerpted from the series of more than 4,000 consecutive cases recorded by Dr. Bennett Bishop, who can usually detect any change in a patient's emotional state by observation of the shadow of the "string galvanometer."

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*See POPULAR RADIO *for June*, 1922.

muscular activity which produce the sounds may be studied with other types of apparatus already in hand, notably the electrocardiograph. General Squier's experiment has special interest, however, as representing perhaps the first attempt to utilize the sensitive mechanism of the radio apparatus in the study of a physiological function. The application was made to the heart for obvious reasons; but it may be taken for granted that the activities of other organs will presently be brought within range of observation from the new coign of vantage afforded by the necromantic electron tube. The nearest-to-hand possibility appears to be the investigation of the electrical manifestations associated with the functioning of the nervous system. It is this aspect of the problem toward which my own projected investigations are directed.

It has long been known that the living body is a generator of electricity. To prove this, nothing more is necessary than to place a sensitive galvanometer in a loop of wire and bring the ends of the wire in contact with surfaces of the body —for example, holding a wire in each hand. This completes the circuit; the body acts as a battery, causing a current to flow through the wire, deflecting the galvanometer.

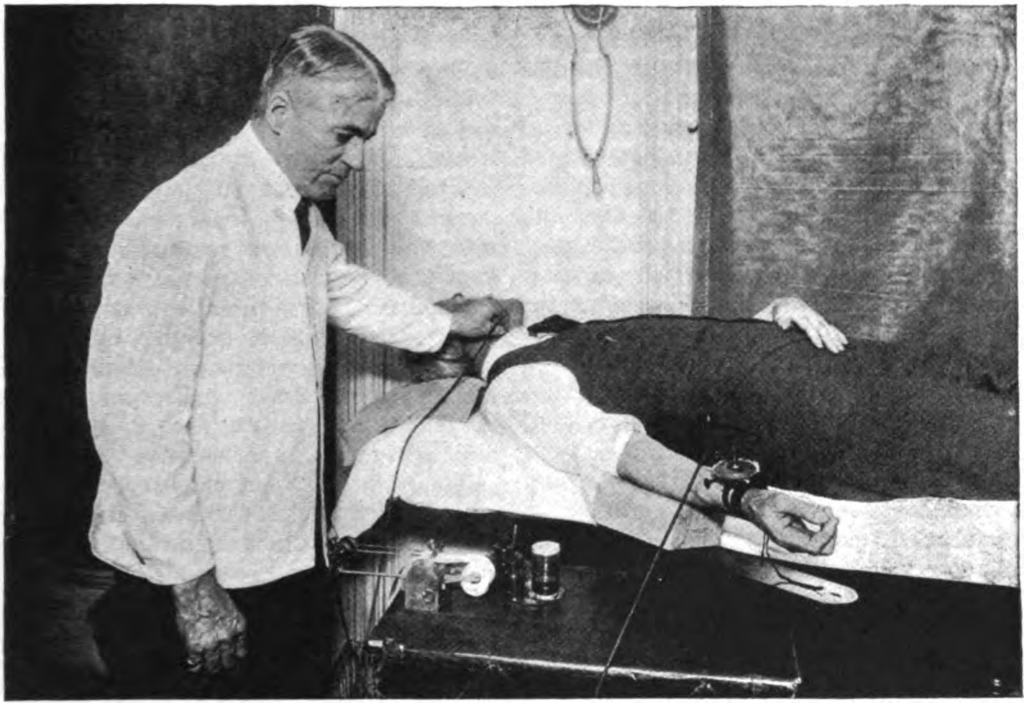
Interesting tests have been made with this simple apparatus in the endeavor to determine whether the amount of current that flows through the wire is modified by changing mental or emotional states of the person under observation. Such changes have been noted (they are, indeed, easily demonstrable), but competent observers have expressed the opinion that the modification is due chiefly to increase or decrease of moisture of the skin, caused by perspiration. It is common knowledge that emotional conditions affect the cutaneous circulation—as is evidenced, for instance, in the phenomenon of blushing. A greater or less amount of perspiration exudes from the pores concomitantly; and of course a moist skin offers less resistance than a dry one to the passage of an electric current.

So the galvanometer experiments, which at one time seemed so promising, led to no very definite conclusions as regards fluctuations in the development of electricity in the human battery. It seemed necessary to find a more delicate instrument for testing electrical currents before real progress could be made.

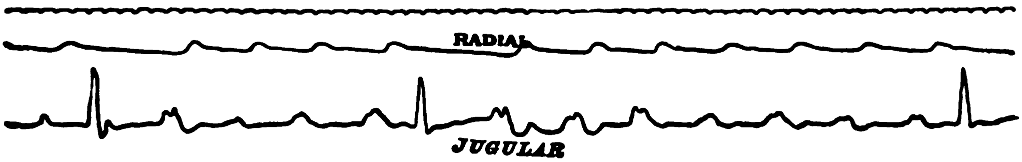
Such an instrument is found in the electrocardiograph. This is a large and rather cumbersome piece of machinery, occupying a stand or table several feet in length; to casual inspection it suggests power rather than delicacy of operation. Yet its really essential part is a little filament of glass, of spider-web proportions, upon which a thin layer of gold has been deposited by electrolysis. The thread of gold thus devised is sometimes called a string galvanometer. It is stretched crosswise in the space between the poles of a relatively huge electromagnet; its ends are connected with wires through which an electric current might pass. The other ends of the wires, when the apparatus is in operation, are connected with electrodes designed to be placed in contact with surfaces of the human body.

Gold, as is well known, is a non-magnetic metal, but it is an excellent conductor of electricity. It is equally well known that when an electric current passes along a conducting wire, there is developed round the wire a magnetic field that comes to grips, so to speak, with any other magnetic field that may invade the same territory.

It follows that the magnetic energy of the electromagnet does not affect the gold thread when not electrified; though it would instantly rupture a thread of similar size made of steel or other magnetic metal. But when a feeble electric current passes along the thread of gold, there is instant mutual attraction between its field and that of the magnet, with the result that the thread is pulled vigorously in one direction or the other according



From a photograph made for POPULAR RADIO



RECORDING IN GRAPHIC FORM THE REACTIONS OF THOUGHT

This apparatus, known as a "polygraph," records mental actions as reflected in the mechanical action of the heart, transmitting through the blood to the wrist and neck of the patient. Compare this record with the electrical record of the electrocardiograph on page 11.

to the direction of flow of the current it carries.

Any deflection of the thread is therefore tangible evidence of the passing of an electric current; and the amount of deflection measures the relative strength of the current. If the wires joined to the end of the thread are put in circuit with the human body, we shall know whether electricity is generated or stored in the body, and whether the current fluctuates.

This could not be determined by direct observation of the little gilded-string galvanometer, to be sure, inasmuch as the tug of the magnet will deflect it to only an infinitesimal degree. But there is an arc light at the other end of the table on which the magnet rests, and this throws a concentrated beam through the chamber in which the little gold thread is strung, and casts a shadow of the thread on a disc several feet away. This shadow, of course, reveals the movements of the thread in greatly magnified proportions.

Across the disc that carries the perpendicular shadow is a little horizontal slit which is in effect the eye-piece of a camera in which a photographic film is automatically unrolled, so that it passes across the slit and is everywhere affected by the light except where the shadow of the little gold thread shields it. This shadow, projected through the hair-like slit, becomes a mere point that moves back and forth as the galvanometer thread oscillates, and thus records a zigzag line on the strip of celluloid.

This zigzag line is the record of the varying strength of the electric current that passed through the little gold wire. It tells, therefore, of fluctuations in output of the current generated in the human body. Specifically, as the apparatus is actually used in medical practice, the record has to do with currents of electricity being generated by action of the heart.

The patient whose heart is thus allowed to make a photographic diagram of its own action sits in an arm chair at a little distance from the apparatus, with an electrode attached to each wrist and to his left leg just below the knee. The metal electrodes are in direct contact with the skin, and a cloth saturated with salt water is wrapped about each wrist to insure better contact. All three electrodes are not in circuit at the same time, of course. It is obvious that there are three possible combinations: (1), between right arm and left arm; (2), between right arm and left leg; and (3) between left arm and left leg.

Three pairs of insulated wires lead from the patient's arms and leg to an apparatus beside the electromagnet, through the operation of which the operator, by turning a knob, can establish any desired one of the three possible circuits.

There must, of course, be a difference of potential between the different pairs of electrodes, else no current would flow. This difference in potential, as recorded by the shadow on the actual cardiogram, is measured in millivolts, or thousandths of a volt. The balance of potentials changes from moment to moment in cyclic manner, in response to the rhythmical activities of the heart; it is these changes, of course, that are recorded as zigzag tracings on the photographic film in unison with the fluctuations of current in the gilded thread that casts the shadow.

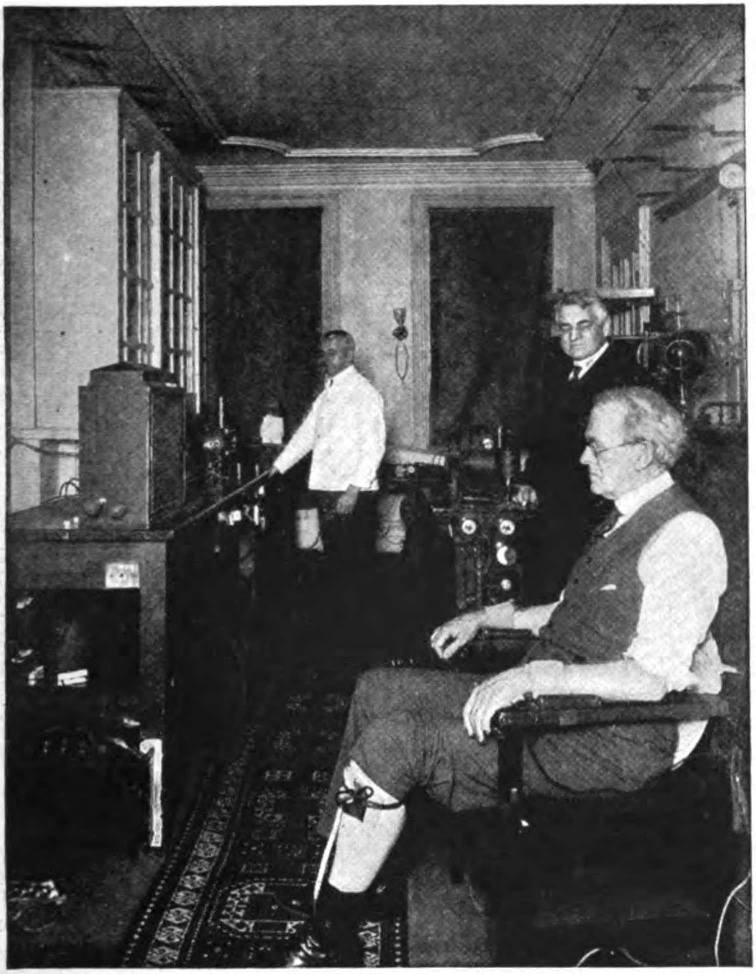
Between arm and arm the difference of potential is usually relatively slight, and between right arm and left leg there is usually somewhat less conspicuous variation than between left arm and left leg. Minor oscillations have significance and interest only for the heart specialist. It may be noted, however, that no fewer than thirty possible departures from the normal are listed, for all of which the heart specialist must keep an open eye in analyzing the electrocardiogram, although only a few departures will probably be found in the case of any individual record.

The particular item which concerns us most in the present connection is that which notes a "movement line due to nervousness or restlessness." This clearly suggests that an emotional state may modify the electrical current generated by the heart's action.

There is not the slightest question that such a supposition is valid. To illustrate the point, observe this electrocardiogram (Figure 1); it shows two quite different series of oscillations. When the first zigzag line was being registered, the operator, Mr. Bishop, watching the shadow of the gold thread on the disc, realized that something was wrong. He interrupted the action of the apparatus to interrogate the patient. She replied that she was solicitous about the safety of her jewels, which she had left in her purse in the dressing-room. She had heard steps in the hall, and feared that the person who had gone toward the dressing-room might purloin the jewels!

That explained the anomaly. The jewels were sent for, the session was resumed, and the shadow now oscillated normally, producing the second and quite different series of lines shown by this electrocardiogram.

Such modification of currents from the cardiac generator are frequently observed by the expert who operates the electrocardiograph. The origin of the modification may be physical discomfort, or (as



From a photograph made for POPULAR RADIO in the office of Dr. Louis Faugeres Bishop

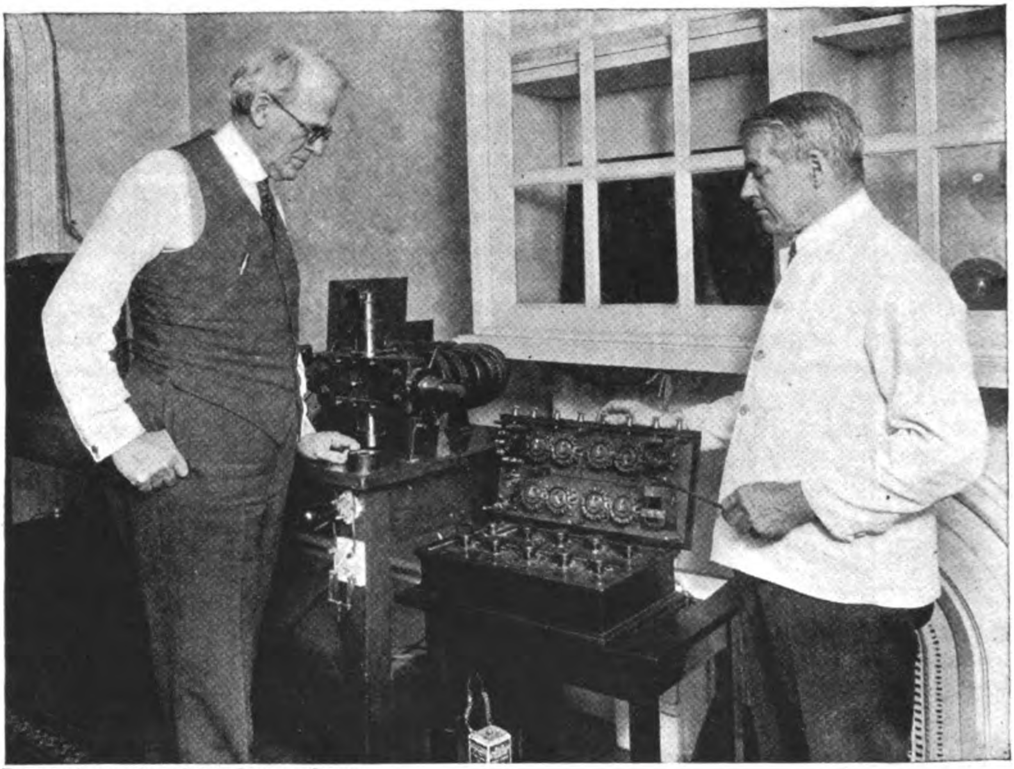
HOW AN "ELECTROCARDIOGRAPH" IS MADE

The experimenter is in the position occupied by a patient during the taking of an electrocardiogram. Electrodes are adjusted to the wrists and left leg to complete the three alternative circuits. The electromagnet in front of the operator shows the location of the "gilded-string galvanometer," the shadow of which is thrown on the white disc beyond by a beam of an arc light. Six-volt storage batteries, like those used in the radio receiver, are used to operate the apparatus.

in the case just recorded), a purely mental departure. It is possible to produce modifications by an effort of will, in case of a patient of good powers of mental concentration.

At first blush, this might seem to imply that in such case measurement has been made of modifications of electrical current directly associated with mental processes—the equivalent of brain activities. But a moment's reflection shows that such an inference is not justified. All marked mental and emotional changes are reflected more or less in modifications of cardiac action; and it is the modification of heart action that directly changes the electrical potentials. It is reasonable enough to assume that there are electrical phenomena directly associated with the changing brain activities; but if existent they have not hitherto been differentiated from the changes demonstrably due to modified heart action.

The essential point, however, is that



From a photograph made for POPULAR RADIO

HOW THE "ELECTROCARDIOGRAPH" WORKS

By adjusting the resistances of the electromagnet, the current is stabilized and extraneous currents are shut off, thus regulating the voltage of the cardiac currents.

electrical currents generated in the human body are registered graphically by the electrocardiograph. It remains to inquire whether the apparatus, as usually employed or in any modification, can be made to differentiate more accurately between electric currents originating in different parts of the body—leading up, of course, to the really salient question as to whether we can gain any clues to direct modification in the electrical output of the brain mechanism itself in association with modified mental states.

This is a problem which I have discussed with Dr. Louis Faugeres Bishop, the New York heart specialist, and his brother, Dr. Bennett Bishop, and for which we are trying to find a tangible answer. Dr. Bennett Bishop has taken electrocardiograms of more than four thousand consecutive cases in recent years, supplemented in many cases with notes that throw interesting side-lights on the problem of electrical response to brain activities. But, as already suggested, these records cannot by themselves furnish unequivocal testimony, for the electrical current in evidence must be assumed to be always chiefly of cardiac origin.

It is a fair presumption that currents developed in other organs would be far feebler than those developed by action of the enormously powerful heart muscles.

On the other hand, it is a valid assumption that there must be an electrical accompaniment of the action of all bodily tissues; since, according to modern theory, all chemical action is essentially electrical action. Every organ of the body must be in effect an electrical battery. And no one who had thought much on the subject is likely to doubt that electricity plays a larger role in the living organism than has usually been ascribed to it.

Many radio workers, including some not without knowledge of physiology, have been astonished to learn that the human body has appreciable electrical "capacity," and that its store of energy cannot be disregarded when dealing with the sensitive radio receiver. Every radio expert knows that the operation of a delicately adjusted regenerative circuit may be radically modified by approaching the hand to the apparatus. Many novices have amused themselves by "playing tunes" on oscillating tubes by light manipulation with the fingers.

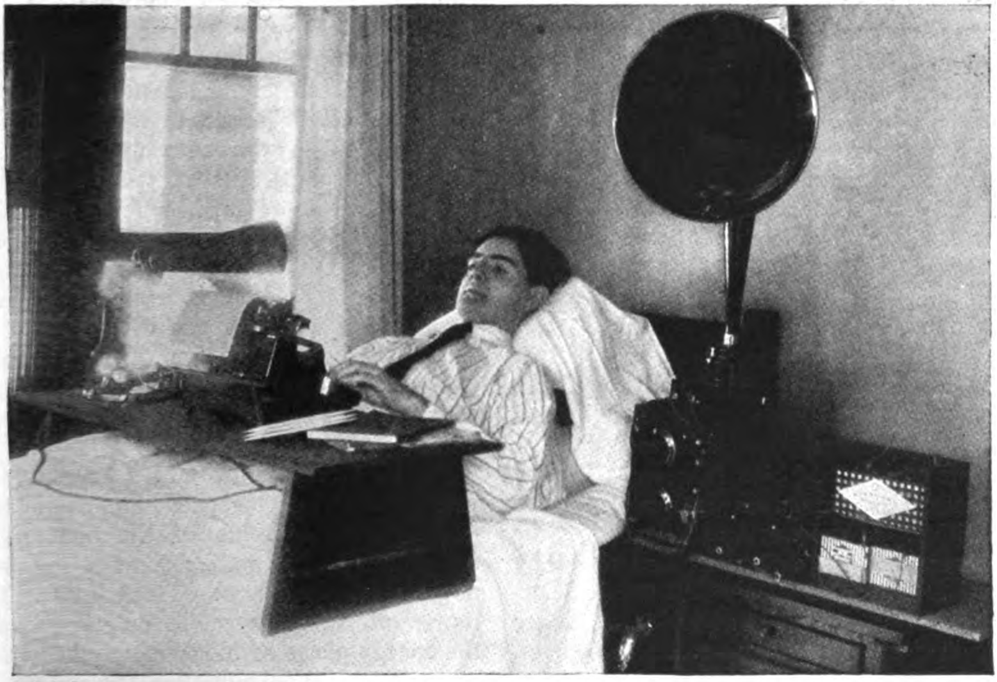
Incidentally, it may be noted that the tube thus heterodyned may send its messages out along the receiving antenna, which now becomes a transmitting antenna as well, to the exasperation of other operators of receivers in the neighborhood.

Obviously, then, the human body is a condenser of not insignificant capacitance.

We must recall, however, that electricity thus stored in the body is not all, of necessity, generated in the bodily tissues. The charge may come from without. When, on a cold day, you scuff your feet along the carpet and then light a gas jet with a spark from your finger, or "draw" visible sparks from the steam radiator or water faucet, you have obviously generated by surface friction the charge for which your skin acts as condenser.

We are almost constantly charging our bodily surfaces by frictional contact with various objects, but we are even more incessantly developing electricity from within. Our bodies are, in effect, living radio apparatuses—having inductance and capacity, with local sources of electrical supply.

It has been shown that the body may act as an aerial on occasion, when connected with an ordinary radio receiver. Why, it may be asked, may it not act as



A. J. DeLong

WHAT EFFECT WILL BROADCAST PROGRAMS HAVE ON INVALIDS?

The mental attitude of a patient is an important factor in his treatment. That radio may influence it "suggests unexplored possibilities in hospitals and other institutions, for diversional and even perhaps curative effects," states Dr. Williams.

an aerial when it is not so connected?

The question has implications that are rather startling. It seems to suggest the possibility of direct transfer of energy from one person to another through ethereal channels hitherto unrecognized—or at least not recognized by those of us to whom the evidence for the existence of what is called telepathy, as hitherto presented, is altogether unconvincing.

May it not be that there is some form of energy radiated from the human body during the chemical action in the brain accompanying the process of thought, that there is more than "mere words" exchanged between two persons in conversation. This may be some form of radiant energy.

And after all there is no reason why one should find the suggestion disconcerting. It might rather be said to be, reasoning from analogy, in line with what one should *a priori* expect. For there is no question at all that certain lower organisms are provided with radio apparatuses, operated by their vital tissues. I refer to the numberless instances in which animals appear to exercise a "sixth sense," to the bewilderment of human observers; and, more specifically, to the fact, as chronicled by Professor Jacques Loeb, that a butterfly may come directly to its mate, obviously under some guiding influence, when the mate is securely shut up in a cigar box by an open window in a room.

If that observation is not accepted as conclusive evidence, it is necessary only to point to the case of the fire-fly and the glow-worm. These insects develop radio currents of high frequency, for the electromagnetic waves they send out are visible light waves. And such waves, be it recalled, are universally admitted by physicists, since the time of Clark Maxwell, to be one in kind with the longer oscillations that we now call radio waves.

It is not mere fantasy, then, but a matter of established and even familiar fact, to say that certain lower organisms carry with them radio-transmitting apparatuses, operated by the vital activities of their own tissues.

Therefore it is not fantastic to suggest that human organisms also may retain this function in modified form. It is not fantastic—but neither is it an assumption to be accepted as proved by mere reasoning from analogy. The vital question is: Can we secure tangible evidence of the existence of such a capacity?

That is the ultimate issue that lies back of the problem which Dr. Bishop and I are preparing to investigate.

My own interest in the matter was stimulated by certain observations in connection with the use of the high-frequency current (the same current that generates radio waves) in the treatment of patients in my office; and by theoretical consideration and practical observation of the electron tube, or triode, which is admittedly a new instrument of precision of unexampled delicacy.

Until recently electricity has played a minor role in practical medicine. It is destined, I believe, to become an agent of the utmost significance. And the transition will be effected, I strongly suspect, through studies connected with apparatus made available by the radio engineer. For no available apparatus except the triode has the qualities of sensitive response and amplifying power that are indispensable for the effective investigations of electrical currents of such tenuousness as those which we must assume are associated with the operation of individual bodily organs, and in particular with the functioning of that organ of organs, the brain.

An implement which, in recently developed circuits, has proved capable of dealing with currents of the order of magnitude of the millionth of a microampere (the *trillionth* of an ampere!), may conceivably reveal to us secrets of the energy-phase of biochemical phenomena not less important than the physical secrets of histology and pathology revealed by that other wonder-working instrument, the microscope.

The School Teacher Who Harnessed a Darning Needle

MAKERS OF MODERN MIRACLES—NO. 2

The True Story of Joseph Henry, Long an Obscure Scientist, Who Laid the Foundation for Radio with Experiments on Which the Modern World of Electricity Largely Rests

By THOMAS COMMERFORD MARTIN

IF it were not for a common metal darning needle, laboriously wrapped about with a wire insulated by bits of silk picked from a waste bag as far back as 1827 by an obscure school teacher, it is not only possible but probable that radio, as we know it today, would be a phenomenon yet to be discovered.

The world has a habit of praising a man who blows away the last veil of obscurity surrounding some scientific fact —and of forgetting the pioneers who blazed the trail in the years that went before. Everyone knows Marconi and Tesla; De Forest's name is a byword in thousands of homes; the "Armstrong Circuit" is spoken of as we have become accustomed to speak of the Pullman car. But who knows Joseph Henry and his early experiments with the darning needle?

It is too much to say, perhaps, that Joseph Henry and his darning needle started the wireless ball rolling, yet his efforts have a peculiar significance in studying two later luminaries of the radio world—Hertz and Maxwell.

The modern radio fan is apt to think that electric wires are grown with insulation on them and must be "skinned" if they are to be used bare. It is hard for him to think that insulation had to be invented. Yet it was this simple invention, and methods which now seem as simple, that helped Henry to discover the nature of the oscillatory spark discharge essential in wireless.

Henry spent his youth in the public library at Albany, N. Y., where he surreptitiously read the popular fiction of his day. His most ardent desire was to become an actor; for some time he was sharing in the amateur theatrical performances of his neighborhood. Then a series of popular lectures on scientific subjects attracted his attention and his interest in the theater waned.

It was at the famous old Albany

Academy that Henry did the earlier part of that experimental work which he continued with brilliancy at Princeton, and which made him the worthy peer of Faraday as the contemporary discoverer of the principles of electro-magnetism, upon which all the modern electrical arts and industries are based. There was much in common between the two men and they became friends. The Englishman had no mathematics; the American became a mathematical professor; with unlike methods of approach they were both passionate devotees of physical research in novel fields with results fruitful for the benefit of mankind.

The wonder is that Henry ever found time to do the monumental work that placed him so conspicuously in the Hall of Fame. The Albany Academy, once dubbed a "college in disguise," began its courses lowdown when the young professor took hold in 1826. He had to teach seven hours a day; half that time he drudged with a large class of boys in the elements of arithmetic. Some of his classes met at 6 o'clock in the morning. It is marvelous that Henry found any time at all for the researches and experiments that made him a commanding figure in science. The room he used as a laboratory was only at his disposal during vacation; moreover, his financial resources were utterly inadequate. His contemporary, Faraday, on the other hand, enjoyed all the resources of the Royal Institution in London. Just what the spare cash of inpecunious Henry was may be inferred from the fact his professional salary was only $83 a month.

In his room at the Albany Academy Henry strung up a fifth of a mile of wire. Here he developed the electro-magnet, which paved the way for inventions more directly connected with radio. He shares the honor of inventing the magnet with Sturgeon and with Michael Faraday, who made experiments which ran more or less parallel with his own.

By carefully wrapping his wire in silk and winding it around an iron core, Henry developed electro-magnets which performed unusual feats when they were energized by a primary battery that contained only 2/5ths of a square foot of zinc surface and that required only a half-pint of diluted sulphuric acid for its submersion.

He had been making magnets for five years and earning only $250 a quarter when he wrote in *Stillman's American Journal of Science* for January, 1831:

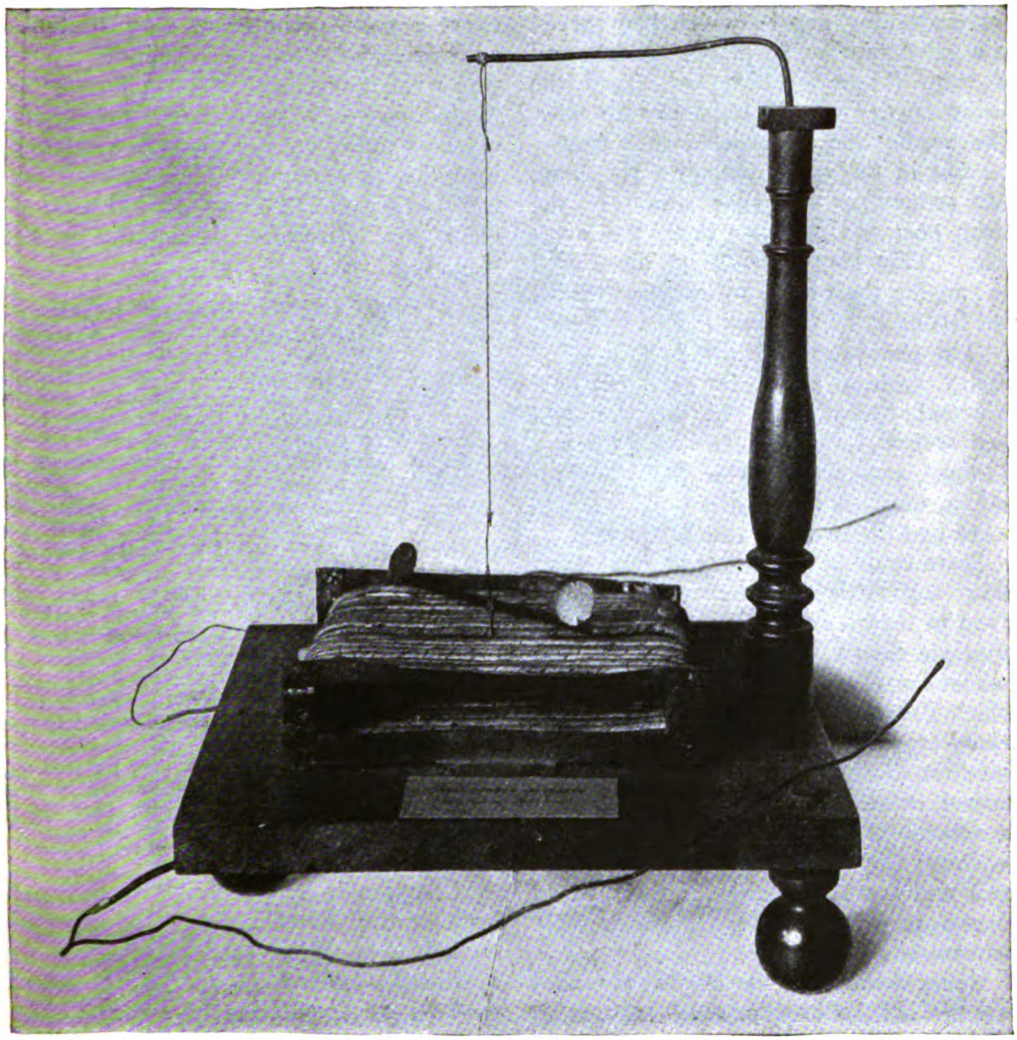
"Our new magnet weighs 21 pounds and lifts more than 35 times its own weight. It is probably, therefore, the most powerful magnet ever constructed."

By winding several insulated layers of wire around his iron core he produced at least a hundred times more magnetism than had Sturgeon with a similar battery and a single layer of wire on an electro-magnet of equal size and weight. A short time later, Henry made an improved type of magnet for Yale University; it weighed 82½ pounds and lifted 2,300. Later he made a magnet for Princeton University which lifted 3,000 pounds. By suddenly reversing the current through it he astonished his pupils by causing the magnet to drop its armature and seize it again before it had fallen beyond the sphere of attraction, thus demonstrating the principle which is employed in every stroke of the neutral relay of the quadruple telegraph of today.

Soon Henry found a way to make the armature of a magnet tap a bell at a distance of nearly half a mile, developing the principle which made possible the Morse telegraph.

He refused to take out a patent for his device, although he had the fundamentals of the electric telegraph in actual operation, "because he did not think it consistent with his position as a scientist." For this reason, the patent office, the "graveyard of buried hopes," has no record of his early work.

Ten years later, Samuel F. B. Morse patented the first telegraph and secured a money grant from Congress with which



THE FIRST GALVANOMETER EVER MADE

Its inventor built it merely to demonstrate a scientific truth; neither this device nor its companion, the electromagnet, were thought to have any commercial value. Yet the withdrawal today of the property developed from these "toys" would paralyze all civilization.

to complete his experiments. To quote this modest Henry himself:

"The principles I had developed were applied to render Morse's instruments effective at a distance."

The discovery of the "extra spark" led Henry directly into the realm of radio. In his own words, "A wire coiled into a helix gives a more intense spark than the same wire uncoiled, and a ribbon of copper coiled into a flat spiral gives a more intense spark than any other arrangement yet tried." Such a flat spiral is used today in the oscillation transformer of radio stations.

Henry was first to note and record the oscillatory nature of the discharge from a Leyden jar, or (as we call it now) a "condenser." He knew the condenser to be a storehouse for electrical energy, the charges of electricity attracting and holding each other on the two conducting plates of metal which are separated by glass, air or other insulation.

His darning needle, which had served as a galvanometer, he placed inside a coil of wire through which he caused the stored energy of the condenser to flow. The needle was magnetized each time—but not in the same manner. He noted that sometimes the point would be the north pole and at other times the south pole. This simple truth he discovered by hanging the needle up by a fine thread and letting it swing like a compass needle.

"The phenomena require us to admit," Henry wrote in 1842, "the existence of a principal discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding, until equilibrium is obtained."

He had discovered radio frequency.

There could be no radio communication today without this fundamental principle. Even in those early days, Henry saw the principle clearly. He realized that there was tension on the plates of the condensers which drew the unlike charges of electricity together and he understood that at the first discharge more of the charges rushed from one side than were needed to neutralize the condenser and that consequently some of the charges had to rush back and forth thousands of times in an instant until the condenser plates were neutralized.

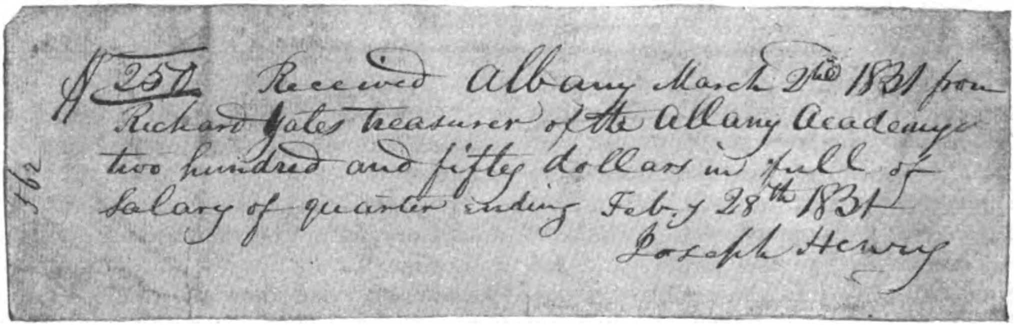
Henry went about developing the next essential of radio almost at once. He found that an electrical current could exert a peculiar influence at a distance entirely without the use of wires. This was what is now so commonly known as "induction"—the same property which causes a radio wave to produce a current in a distant antenna and so make itself heard in a radio receiving set. His statement is a recognized landmark in the history of science:

> "In extending the researches, a remarkable result was obtained in regard to the distance at which induction effects are produced by a very small quantity of electricity.
>
> "A single spark from the prime conductor of a machine of about an inch long thrown on to the end of a circuit of wire in an upper room produced an induction sufficiently powerful to magnetize needles in a parallel circuit of iron in the cellar beneath, at the perpendicular distance of 30 feet, with two floors and ceilings, each 14 inches thick, intervening.
>
> "The author is disposed to adopt the hypothesis of an electrical plenum (ether) and from the foregoing experiment it would appear that a single spark is sufficient to disturb perceptibly the electricity of space throughout at least a cube of 400,000 feet capacity; and when it is considered that the magnetism of the needle is the result of the difference of two actions, it may be further inferred that the diffusion of motion in this case is almost comparable with that of a spark from a flint and steel in the case of light."

"Comparable it is indeed," is the comment of Sir Oliver Lodge, "for now we know it to be the selfsame process."

Henry's bed-rock experiments were used as the foundation of radio.

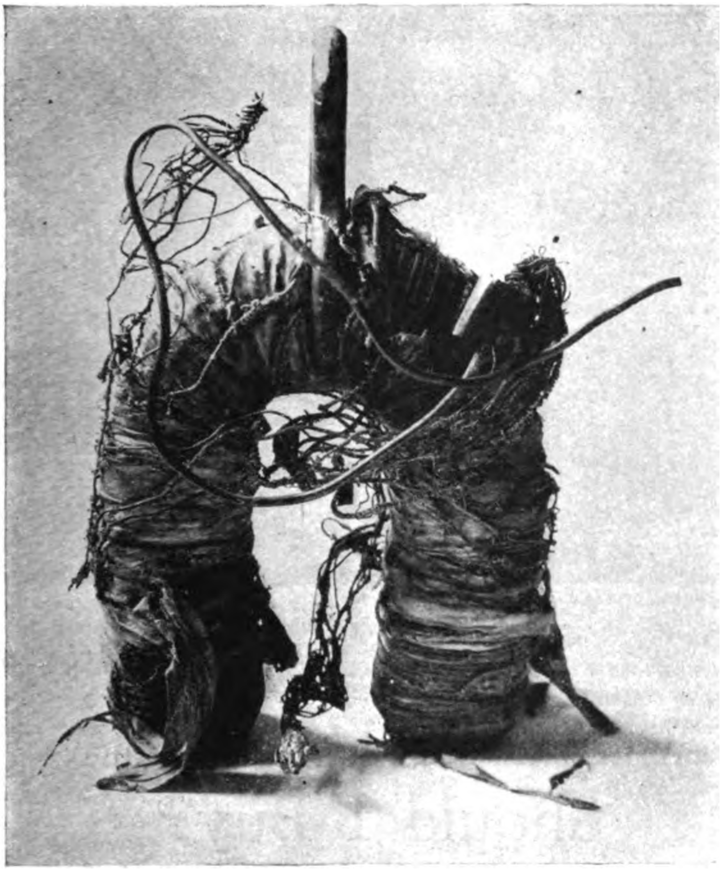
Lodge's experiments in resonance phe-



$250 Received Albany March 2nd 1831 from
Richard Yates treasurer of the Albany Academy
two hundred and fifty dollars in full of
salary of quarter ending Feby 28th 1831
Joseph Henry

THE REWARDS OF GENIUS

At the very height of his career, when Henry was making experiments of the most far-reaching value to mankind—experiments that mark the beginning of modern radio—he was earning but $19.23 a week, or about as much as a competent office boy gets today. (The original paper is owned by T. C. Martin).



THE FATHER OF ALL ELECTROMAGNETS

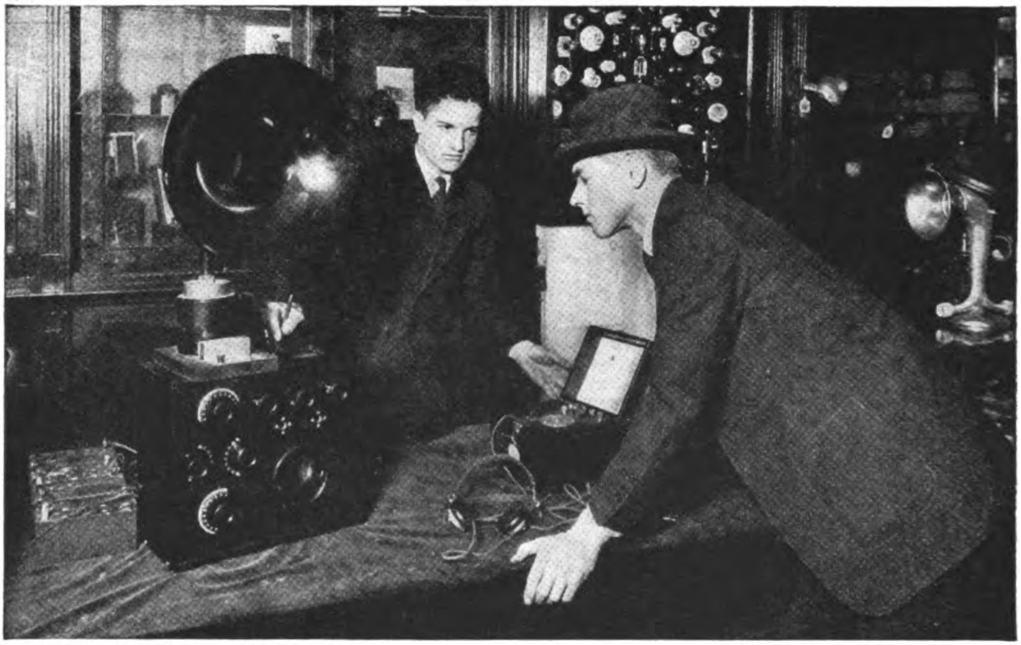
This famous relic—now preserved at Princeton University—was the first instrument made to generate a current of electricity in a coil of wire. These coils were wound by hand by the inventor, Joseph Henry.

nomena developed the wave theory. He found that by using two Leyden jars or condensers of the same size and by employing similar lengths of wire to connect the plates, a discharge from one would produce a sympathetic discharge from the other. He discovered the process now known as "tuning." This first receiving set was crudely tuned to resonance quite as modern radio sets are tuned with condensers and other helping devices.

Henry's work was taken up by Heinrich Hertz, a professor at Carlsruhe, in 1886. By studying Henry's "extra spark" and the nature of discharges from condensers, he was able to resonate the waves given off and to cause interference between waves, thereby proving conclusively that such waves existed. In his honor, they are called "Hertzian waves," and are the same electrical disturbances which make modern radio possible.

All inventors connected with radio now give Henry a good share of credit for the work they are able to do; he is now universally acknowledged as a pioneer in the new science.

Henry lived long enough to be hailed as a genius and a prophet. The boy who was once apprenticed to a silversmith became a professor at Princeton University and was later placed in charge of the Smithsonian Institution. And in recognition of his achievements the unit of inductance has since been named the "henry."



From a photograph made for POPULAR RADIO

Should he spend $20—or $300? Should he choose a crystal set—or a tube set? Should he buy headphones—or a loudspeaker? What facilities has he for putting up an antenna—and what kind of antenna should he have? This article tells the first-time buyer how to settle these problems himself.

WHAT KIND OF RECEIVING SET

Should I Buy?

Pointed Questions That Every Layman Is Asked When He Starts Out to Select His Equipment, Questions That He Must Decide Before He Makes His Purchase, Here Answered by

EDGAR H. FELIX

THE uninformed layman who selects and purchases instruments for his radio receiver is about as likely to make a wise choice as a Hindu poet attempting to outfit an Arctic expedition.

He is offered the choice of an extensive line of apparatus, each piece of which seems to have certain specified technical merits. Only a few of the instruments are essential, although many others are highly desirable, if the buyer can afford them; but he does not always know this, and after a few minutes of demonstration is lost in a maze of indecision.

Despite the diversity of radio equipment on sale, only a little knowledge is required to make a sensible and economical purchase with due regard to the buyer's financial limitations. The important point is to know exactly what is wanted in the way of results and to watch for defects in construction which are obvious if they are pointed out.

The answer to the layman's general question, "What kind of set should I buy?" may best be answered by a consideration of what he wants his set to do —the service he expects from it

1

"How Loud a Signal Do You Want?"

This is usually the first question to be decided. If the buyer can pay the price he can receive music from a broadcast station more than a thousand miles distant and make it audible for a block or two from his house. On the other hand, a salesman may state truthfully that a certain station can be heard at a certain distance with a particular set, yet that signal may be so weak that it will be drowned out by the ticking of a watch.

The question of signal strength is not hard to settle. It is determined by four factors:

The distance from the transmitting station;
The size of the antenna;
The type of detector used;
The amount of amplification to which the detected signal is subjected.

If the buyer is content to lounge comfortably in a chair with a pair of earphones on his head and is satisfied if but one or two persons may listen in at a time, signal strength of the order obtained on a crystal set or vacuum tube detector set will be sufficient.

But if he wants to dance to radiophone music, or if he wants to make concerts audible to as many persons as he can accommodate in a room, or if the buyer is bothered by the prospect of wearing a receiver on his head for several hours each evening, instruments will be needed which produce much greater signal energy. This must be sufficient to operate a loud-speaking horn, and except for short distances an amplifier is necessary. Provided money enough is spent, a signal can be amplified to practically any degree of strength.

Of course, the distance from the transmitting station is a fixed quantity.

The type of receiver essential to obtain signals of sufficient loudness for head telephones and the type for operating loud-speakers for various distances from the transmitting station can be determined after reading further points discussed in this article.

2

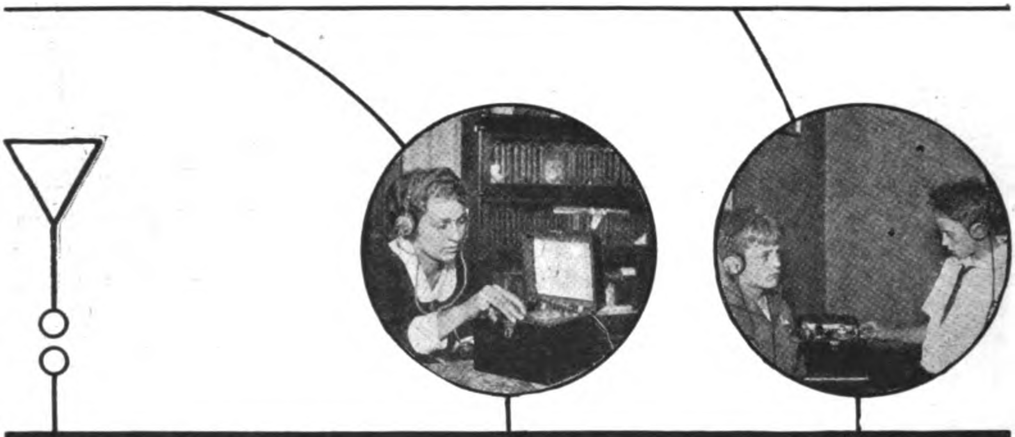
"What Size of Antenna Can You Use?"

The size and design of the antenna partly determine the amount of energy which is collected to actuate the receiver, just as the distance from the transmitter determines the amount of energy available.

In general, the longer the antenna the greater the energy received. For receiving purposes many wires are not essential; a single wire is practically as effective as four parallel wires of equal length, and it is easier and simpler to erect. A one-hundred-foot antenna may be considered an average length. In some cases, by increasing the length of a fifty-foot antenna to two hundred feet the signal strength is increased to the same degree as by one stage of amplification. Hence the longer it is practical to make an antenna up to two hundred feet, the louder the signal obtained.

The natural wavelength of an antenna—that is, the wavelength to which it responds without the addition of tuning apparatus—is roughly proportional to its length. For the reception of broadcast music on a wavelength of 360 meters, a one-hundred-foot antenna may be connected directly to the receiving apparatus. A longer antenna requires an artificial means of shortening its natural period or wavelength. This is accomplished by means of a variable condenser inserted in the ground connection or lead-in. With such a condenser, the concerts broadcasted on 360 meters can be heard on antennas of two hundred feet or longer.

When the lead-in to the receiving set is taken from one end of a single-wire antenna, greater energy is received from stations in the direction from which the lead-in is taken. The single-wire antenna may thus be considered as an arrow, with its head or point at the end where the



TYPE OF SET	Ⓐ CRYSTAL SET	Ⓑ SINGLE TUBE SET
DISTANCE RANGE	10 TO 30 MILES	30 TO 75 MILES
COST TO INSTALL	$20.00 TO $30.00	$45.00 TO $60.00

The five receiving sets pictured on these two pages will serve your purpose—provided you

lead-in is taken. This directional effect is marked and should be taken advantage of by pointing the aerial so that maximum energy is received from the most desirable broadcast station.

Signals received on indoor ærials usually require considerable amplification: *First,* because the indoor antenna is limited in size; *secondly,* because some of the energy is absorbed by steel girders or other metal parts of the building in which they are located. For these reasons, outdoor antennas are recommended.

Indoor antennas are of two types, loop and flat top.

The loop antenna consists of a number of turns of wire mounted on a frame (usually one to three feet square), so arranged that the loop may be rotated on a horizontal axis. A loop has strong directional characteristics, hence interference from stations in directions other than that at which a desired station is located may be reduced or eliminated. But the loop antenna collects so little energy that many stages of amplification are necessary to make a signal of strength equal to that obtainable from a long single-wire outdoor antenna—and amplifiers are costly.

An indoor flat-top antenna consists of one or more wires stretched through the greatest available length.

If an indoor antenna is long enough and located high enough in a building, it may approach the efficiency of an outdoor antenna of equal length, provided the absorption from the steel framework of the building is not too great.

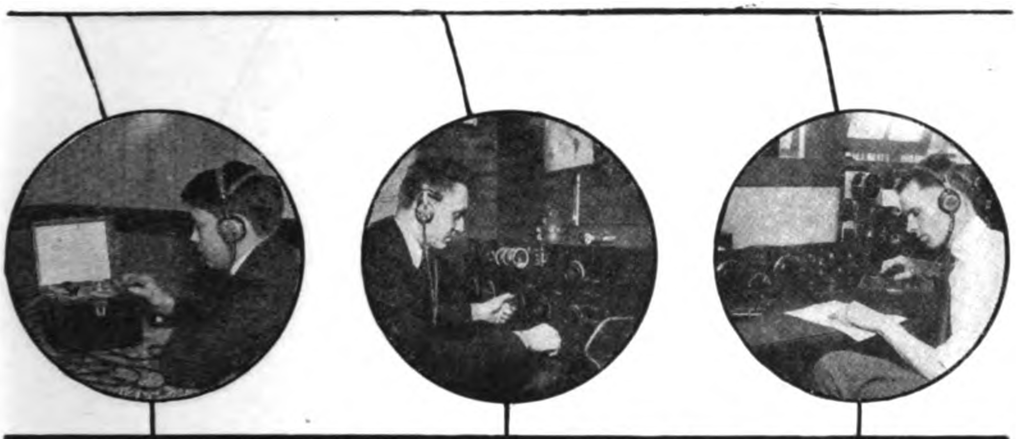
3

"What Detector Will You Choose?"

Receiving sets may be classified thus:

- Those that employ crystal detectors;
- Those that employ a vacuum tube as detector;
- Those that employ a vacuum tube detector with a regenerative circuit.

The crystal detector is the least expensive type. For short-distance work, it gives a satisfactory signal in the telephones. The vacuum tube detector is more



Ⓒ SINGLE TUBE REGENERATIVE SET	Ⓓ REGENERATIVE SET WITH SINGLE-STAGE AMPLIFIER	Ⓔ REGENERATIVE SET WITH TWO-STAGE AMPLIFIER
75 TO 200 MILES	200 TO 500 MILES	500 TO 1500 MILES
$60.00 TO $80.00	$80.00 TO $100.00	$125.00 TO $175.00

are content to use headphones that will permit only one or two persons to listen in at a time.

expensive but it is a much more stable device and gives a signal approximately twice as loud as a crystal detector.

The vacuum tube detector employed with a receiving set that uses a regenerative circuit is still more sensitive, although it requires greater skill in adjustment. The degree of regeneration is determined by the adjustment of the tickler or regeneration control. If too great a degree of regeneration is employed the quality of the received music will be distorted, and if a still greater degree is used the music will be entirely destroyed. But a set in this condition (it is then acting as an oscillator or transmitter) is capable of receiving C. W. (continuous wave) telegraph signals, which require ability to read the Continental code for interpretation.

One stage of amplification makes a faint signal comfortably audible in the receivers. A second stage makes such a signal loud enough to hear all over an average room. Hence, if the antenna does not pick up enough energy to give a comfortably loud signal, an amplifier solves the difficulty. Also, if a signal is received sufficiently loud so as to be heard easily with receivers, and it is desired to have it audible throughout a room, an additional step of amplification is necessary.

4

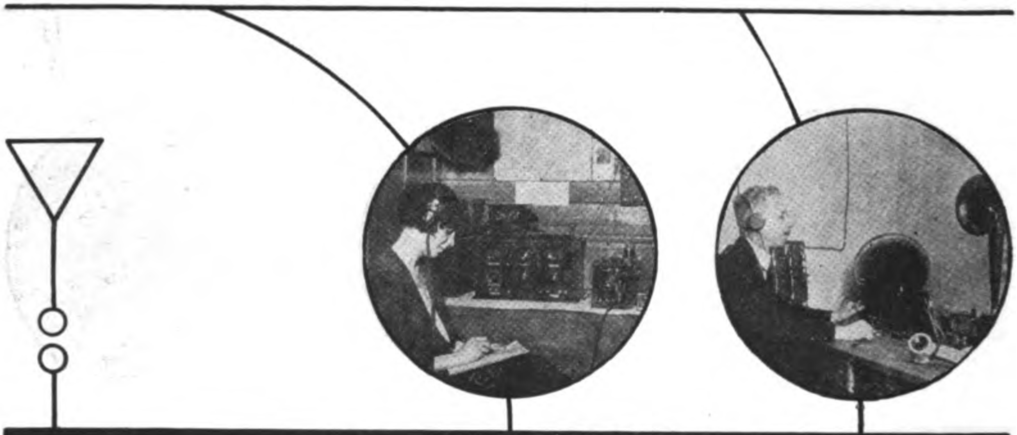
"How Far Are You from a Station?"

Assuming that the antenna is of average length, say one hundred feet, the buyer can then decide just what is necessary for him to purchase to receive broadcast programs from a transmitting station located at a given distance.

For distances up to twenty-five miles, using head telephone receivers, a crystal detector and simple tuner are sufficient.

A vacuum tube detector instead of a crystal detector permits the use of four or five telephone receivers at the same time.

A vacuum tube detector with a receiver of the regenerative type makes a signal loud enough to be audible through a small room, when projected through an amplifying horn. The addition of a one-



TYPE OF SET	Ⓕ TUBE SET WITH SINGLE-STAGE AMPLIFIER	Ⓖ REGENERATIVE SET WITH SINGLE-STAGE AMPLIFIER
DISTANCE RANGE	10 TO 30 MILES	30 TO 200 MILES
COST TO INSTALL	\$65.⁰⁰ TO \$80.⁰⁰	\$85.⁰⁰ TO \$100.⁰⁰

The five sets pictured on these two facing pages are provided with loudspeakers—which will

stage amplifier to this equipment produces a signal audible through a room.

For distances up to fifty miles, a vacuum tube detector is essential to a clearly audible signal. A regenerative circuit increases the range of reception up to 200 miles. A regenerative receiver and one-stage of amplification increases the range for reception from broadcast stations up to 500 miles, and a second stage of amplification brings the range up to 1,000 miles.

In each of these cases an additional stage of amplification brings the signal to sufficient audibility to be heard throughout a room of average size when the signal is projected through a loudspeaking horn. However, it is not advisable to use more than three stages of audio frequency amplification.

5

"Will Interference Trouble You?"

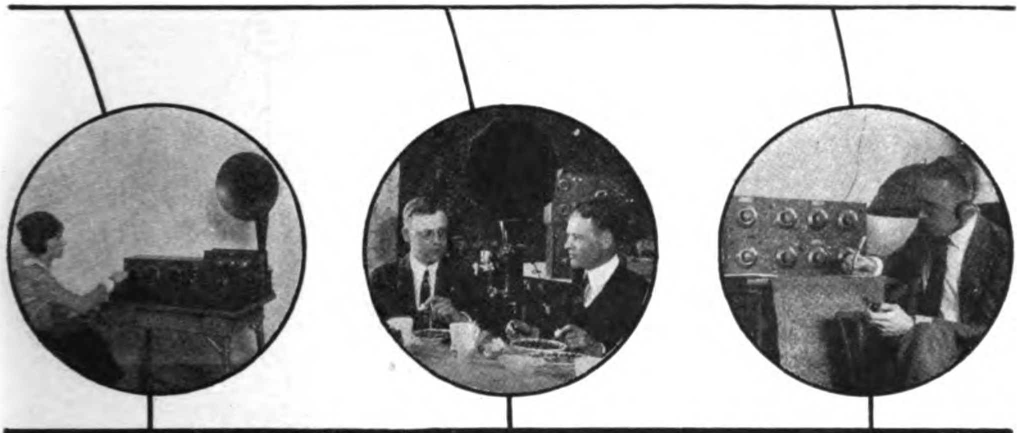
The next point to be decided by the buyer is the selectivity required of his receiving set.

The selective quality of a receiving set is determined by the circuit employed. In general, there are two types: Single-circuit receivers, in which the energy is delivered to the detector direct from the antenna circuit; and two-circuit receivers, in which the antenna is coupled to a secondary circuit tuned to the same wavelength as the antenna circuit, the detector taking its energy from this secondary circuit.

A single-circuit receiver is simple to operate. There is only one adjustment to be made to vary the wavelength to which the receiver responds. But it is not always possible to eliminate a spark station with a single-circuit receiver.

Some two-circuit receivers have been designed, which combine the selectivity of the two-circuit receiver with the simplicity of adjustment of the single-circuit receiver. In such sets, the coupling between the primary and secondary circuit is fixed and the tuning of both primary and secondary circuits is effected simultaneously by a single control knob.

More complicated circuits, such as used by the amateur relay stations, have four



(H) REGENERATIVE SET WITH TWO-STAGE AMPLIFIER	(I) TWO-STAGE RADIO-FREQUENCY SET WITH TWO-STAGE AUDIO-AMPLIFIER	(J) THREE-STAGE RADIO-FREQUENCY SET WITH TWO-STAGE AUDIO-AMPLIFIER
200 TO 500 MILES	500 TO 1000 MILES	1000 TO 1500 MILES
\$175.00 TO \$250.00	\$200.00 TO \$275.00	\$275.00 TO \$300.00

fill a room or an auditorium with sound. No headphones are needed with this equipment.

controls for tuning. One controls the wavelength of the antenna or primary circuit; the second controls the coupling between the primary and secondary circuit; the third controls the wavelength of the secondary circuit; and the fourth the amount of regeneration.

These circuits require skilful adjustment, but with a set so designed interference can usually be eliminated by trying various degrees of coupling and then retuning the primary and secondary and tickler controls.

6

"What Apparatus Can You Afford?"

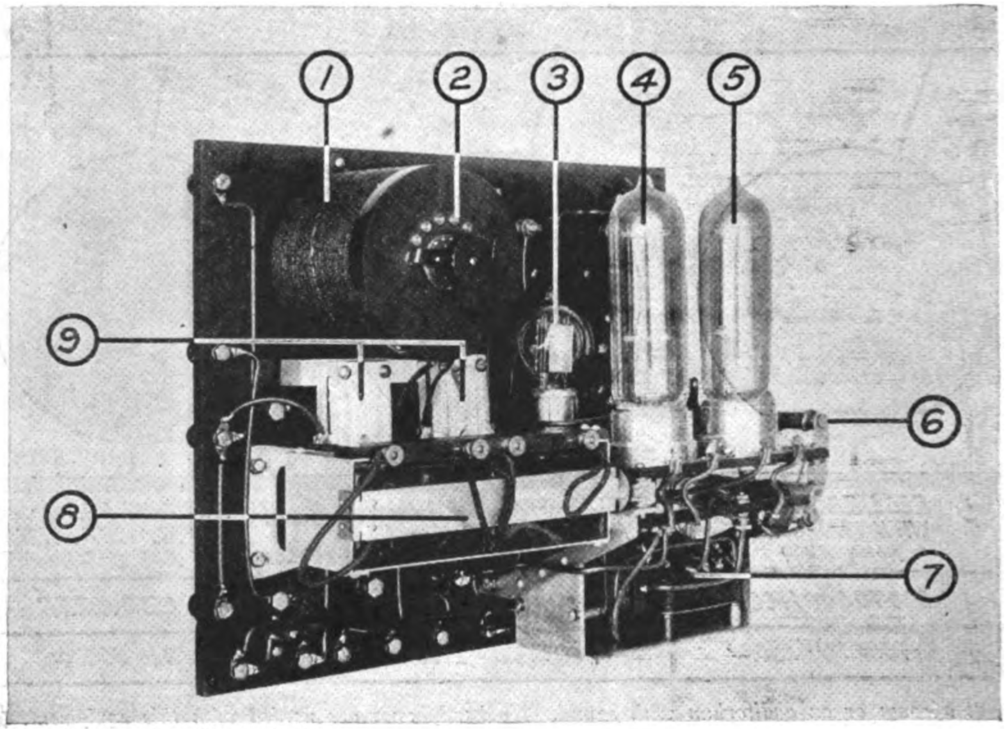
In selecting receiving equipment, a buyer unversed in the radio art is more or less dependent upon the reputation of the dealer who sells and the manufacturer who builds the apparatus selected.

However, certain mechanical defects that are easily detected if the buyer is forewarned should decide him against an instrument possessing them, despite any claims made by the salesman for its electrical efficiency.

In a well-made set, the control knobs work smoothly and easily and with uniform resistance throughout the scale. The dials run true and do not scrape the panel at any point. There is no play in the bearings of the instruments; they cannot be pulled in and out. The lettering is etched in and not merely painted on the surface of the panel. The panel is usually made of one of the synthetic-resinous compounds. The vacuum tubes are accessible and mounted on non-vibrating supports. All wiring is secured firmly in place, soldered at each connection and binding post. All the units in the cabinet are firmly attached to the panel and are readily inspected.

After this beginning and the first enjoyment of listening in, the layman may, and usually will, delve further into the mechanism of receiving sets. He is no longer a tyro.

The "distance range" specified on the charts that accompany this article are conservative approximations, and are intended only for a general guide.



From a diagram made for POPULAR RADIO

A Compact 100-Watt Transmitter

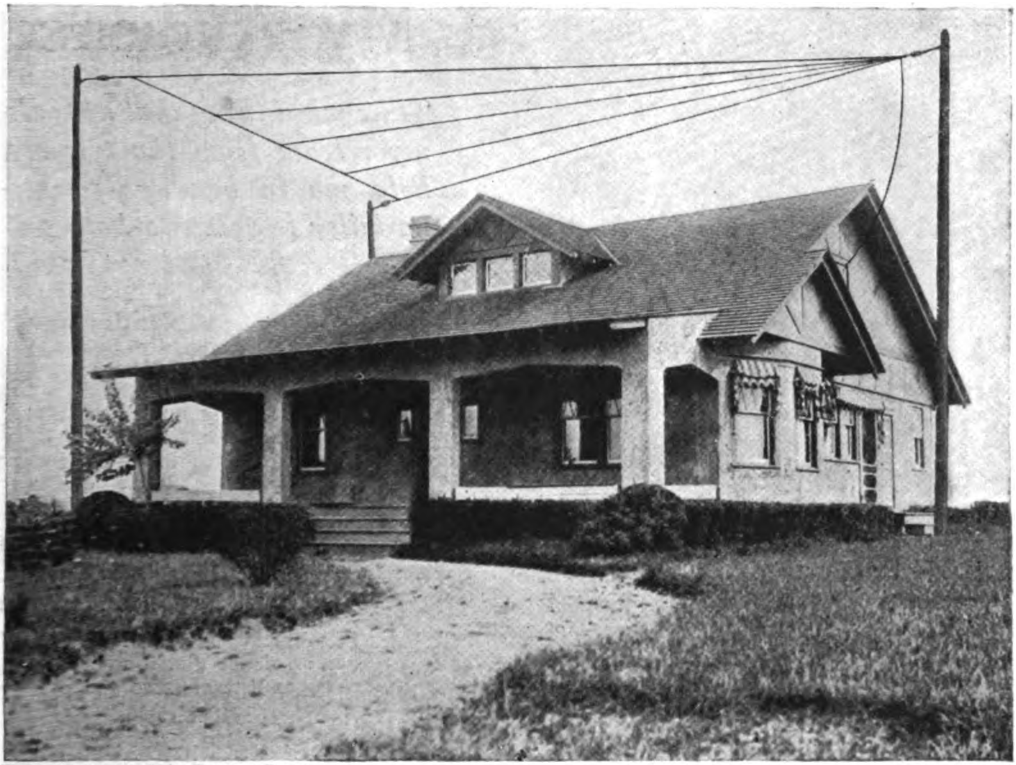
A NEW transmitter developed for the Signal Corps of the United States Army contains many points that will be of interest to the progressive amateur who builds his own apparatus; among them are its compactness and efficiency combined with ease of operation and simplicity.

The illustration on this page shows the inductance coil (1) which is wound with insulated wire and is remarkably small, considering the power that is used. The wavelength switch (which is shown at 2) is variable, so that eight different wavelengths may be used. The transmitting wavelength may be changed by turning the knob controlling the switch.

Three is a 5-watt vacuum tube used for speech amplification. The voice currents generated by speaking into the microphone are increased in strength by passing through the modulation transformer and the small-power vacuum tube. The amplified voice currents are then passed on to the large 50-watt vacuum tube modulator (4), which in turn is used to modulate the input to the oscillating 50-watt vacuum tube (5). In this way the voice currents are impressed on the high-frequency carrier-currents which upon being transferred to an antenna, cause Hertzian waves to be radiated, carrying the voice frequency along with them.

The grid leak (6) for the oscillator tube is mounted beside the tube. The compact assembly containing the modulation transformer, and the low-frequency and high-frequency choke coils is shown at 7. The small compartment for holding the batteries for keeping the grid of the modulator tube sufficiently negative is shown at 8. The two condensers used in the ground and grid circuits, are shown at 9, mounted under the coil. The plate and antenna meters for this set are mounted on the front of the panel.

The circuit used is an adaptation of the well-known Colpit's circuit, using Heising's constant current modulation scheme.



From a diagram made for POPULAR RADIO

THIS AERIAL COSTS ABOUT $11.00—WITHOUT POLES

Usually the wires are attached to trees or buildings, in which case there is no cost for antenna supports. The wire costs about $9.00 and the three insulators about 50 cents each.

An Inexpensive Antenna *for* All-Around Use

NO. 4; THE FAN TYPE

By DAVID LAY

THE fan-type of antenna may be used for either transmitting or receiving. It is rigid in construction and therefore especially suitable for use where the location is swept by strong winds, as there are no heavy spreaders used in its construction.

This type of antenna is less directional than the ordinary flat-topped antenna and for this reason is suitable for long-distance work in all directions of the compass.

The wider the fan is made, the less directional will be the reception or transmission. With a fan of 90 degrees the efficiency will be found practically equal in all directions from the station.

The support for the antenna consists of three masts (or other elevated structures) as shown in the above diagram. One of these masts is located at the lead-in end and the other two masts support the far end; these latter two supports are connected by a wire, to which is attached the ends of the three middle wires. The wires are all joined together and soldered at the lead-in end.

Only three insulators are necessary and no guy wires are used.

This type of antenna is simply constructed; it is efficient and at the same time economical in cost.

My Audience

"The main thing that appeals
my release from the tyranny
held me in bondage twenty
no tailor is going to help put
and not how I

IT was at a broadcasting station near New York that I recently saw the Professor. He had been a feature for years on various Lyceum circuits. I had crossed his trail in the Middle West and the Far West and in the little towns of Northern New York State, where lectures are featured every season. He was a veteran of many summer campaigns which had physically finished more brilliant speakers, who were unable to stand the combined discouragements of hard travel and bad cooking which the entertainer must face on the road. The Professor had been broadcasting his most popular story. I have no doubt that it went well among the army of listeners who generally

IT'S a little hard for me, this radio game, after so many years of the platform. I can't get over the idea that my audience is sitting somewhere, looking at me, just behind that disc into which I am talking. Consequently I go through the same motions that I have fallen into the habit of using on the platform. I gesticulate and smile at the customary time, and bow and scrape just as if those people were sitting out in front. That's the power of habit. Maybe I'll get over it as I continue this broadcasting. But the main thing that appeals to me among the possibilities of radio is my release from the tyranny of the dress suit.

This is all a defiance of the things that have held me enslaved. I am wearing my baggiest trousers and I did not shave this evening purposely. Just before I left home this evening, for instance, I opened the closet in which hangs my dress suit, and I laughed my harshest laugh.

That dress suit has held me in bondage for twenty years. Every day during my career on the lyceum platform, I have trembled lest I should find myself unable to climb into those tyrannizing clothes in time for the evening program. You have no idea how important evening clothes are in such matters. At least they had become so with me. I found that a good appearance on the platform meant about thirty-five percent of my value. It was not flattering to my vanity to have to admit that the tailor and the shirt-maker could claim all the credit for my lyceum success, but I knew it to be true and I stared the facts honestly in the face and made a clothes horse of myself for the benefit of my income.

The clothes value ran higher in other lyceum cases. I know of men who are getting much larger contracts than I was ever able to demand, whose appearance

Beyond *the* Disc

to me in radio broadcasting is of the dress suit. That suit has years. On the radio circuit me across. It's what I say look that counts."

tuned their receivers to get the programs from this particular station. The Professor's shoes were not shined and the trousers of his business suit were bagged at the knees. His face might have been closer shaved, his hair might have been more neatly brushed. Altogether, he presented a marked contrast to the man's usual dapper appearance on the lecture platform, where I first knew him. And then I realized this: that the radio is changing the type of our popular performers. Appearance, gesture, stage presence, clothes no longer count and here is the first-hand account of how this change is taking place in a man who has long been a famous lecturer—and who, for obvious reasons, prefers to remain anonymous.—ARTHUR CHAPMAN

accounts for at least seventy-five percent of their success. By appearance, I mean when they are dressed as if headed for a box at the Metropolitan Opera House. People who hear such men speak are not able to remember anything particularly wise or witty that has been said, but they do recall that the speaker had a nice face or flashing teeth, or—most common of all—that he made a commanding figure in a dress suit. Such men are going to have a hard time of it when it comes to entertaining by radio.

I've had no end of struggles on account of the dress suits I've had to carry along. It has been a nightmare getting my dress shirts laundered, for one thing. If it was impossible to get any laundry, such a calamity always happened in a town so small that the merchants never carried dress shirts and consequently I could not get a new one. Getting my suit pressed was another bugbear. Many a time I have arrived in town half an hour before my time to appear on the program, and have dashed to my hotel, changed into my dress outfit, and rushed to the lyceum hall or tent just as the chairman was telling his last funny story in his effort to hold the impatient crowd.

Some of my traveling has been from town to town by auto. My wife has accompanied me on such trips and she has suffered for me and with me on account of the dress suit nuisance. Except for her aid I should have gone under long ago.

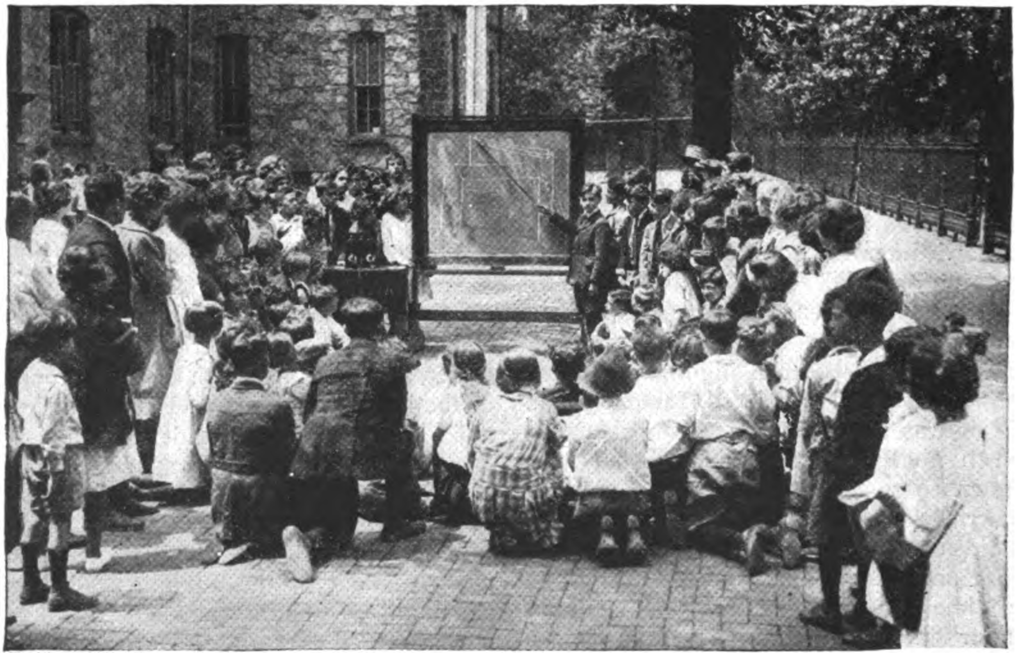
Sometimes, when bad roads have made automobile progress slow, the approach of the lecture hour has found us at an alarming distance from the platform, and gas given out or the machine stalled in the mud. We had a small sedan, and in it we covered part of Missouri and most of Iowa in the hottest summer known. Our car was specially equipped with beds not unlike those in a Pullman, which made us independent of hotels. But I was not independent of that dress suit—not at all!

One evening we were racing for the little town where I was to fill my next engagement. I had shaved hurriedly while eating a sandwich and swallowing a cup of coffee from the meal which my wife had provided, gypsy fashion, at the roadside. But we were ten miles from town and I could not wait to change into that dress suit. We piled our cooking kit into the car and my wife took the wheel and stepped most decisively on the gas, while I climbed into the back of the sedan and lowered the curtains and proceeded to make the required change of clothing.

Getting into one's clothes in an upper berth of a Pullman on the crookedest railroad in the world is simple in comparison with changing into a dress suit in a small sedan while hitting it up on a rough country road to the limit of speed. I was thrown against the roof and against the sides of the car. One of these bumps cost me a slight cut on the cheekbone, which court plaster fixed, but alas! there was a sanguinary mark on my dress shirt. Nothing remained but to drag out another shirt and change into it. The change was effected just as we drove up to the lyceum tent. As I stepped out of that car, it required all my years of experience in control of my facial muscles to dissemble the thoughts that were crowding upon me in connection with the dress suit as an institution.

That's why I have seized upon the opportunities presented by the radio program. To be able to reach one's audience without a care for the formalities of dress—to be as natural and at ease in one's clothes as a Joaquin Miller—it's no small thing.

On the radio circuit no tailor is going to help put you across. It's what you say, and not how you look when you're saying it, that counts.



Pacific & Atlantic

THE WORLD'S YOUNGEST RADIO "EXPERT"

Philadelphia is not so slow, after all; it can at least point with pride to its eleven-year-old citizen, William N. Allen, who has held an amateur radio license for two years. Here William is shown giving a practical talk on radio to his schoolmates.

¶ *Sooner or later every true radio amateur develops a desire for a topnotch long-distance receiving set—a set that he can build at reasonable cost and that will enable him to tune out all interference. This article tells him just how to do it.*

How *to* Build a Real "DX" REGENERATIVE RECEIVER

By LAURENCE M. COCKADAY, R. E.

IN these radio days of interference on both the amateur and broadcast wavelengths a man must have a receiver that will distinguish between minute differences in wavelength if he expects to tune in one station without experiencing jamming from other stations. If he be a real honest-to-goodness telegraphic amateur, engaged in transcontinental relay work, he must be able to tune out all the other amateurs within range in order to copy a distant message from a fellow relay man situated on the other side of the continent; at the same time he must attain this selectivity of tuning without a multiplicity of tuning controls and also without a great loss of sensitivity.

The same condition holds true for his younger brother, the broadcast listener, for both of them are amateurs in different stages of development. The broadcast man soon gets tired listening to the nearby broadcasting station; he wants to reach out and hear the stations at the other end of the country.

With most of the simple single-circuit sets now on the market this is almost an impossibility. How can we tune that distant signal through the amateur transmitting station in the next block or how can we get that speech from Pittsburgh

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"DX" is the amateur slogan for "Long Distance."

with a receiving set that will not tune sharply, when the local broadcasting station is blazing away with a jazz orchestra on almost the same wavelength? What are the requirements for a receiver that will do this thing?

First, the receiver must be finely selective and capable of distinguishing changes in wavelength of two or three meters.

Second, the set must also be ultra-sensitive to pick up and amplify even the weakest impulses.

Third, the set should also be easily and quickly tuned, especially for amateur relay work.

If the set has not these three qualities we might as well junk it. On the other hand, a receiver that has these three characteristics was actually developed by the writer during the late war and has been used and further developed at experimental station 2XK ever since that time. A description of it should prove of interest to the amateur who wishes to listen to "distance."

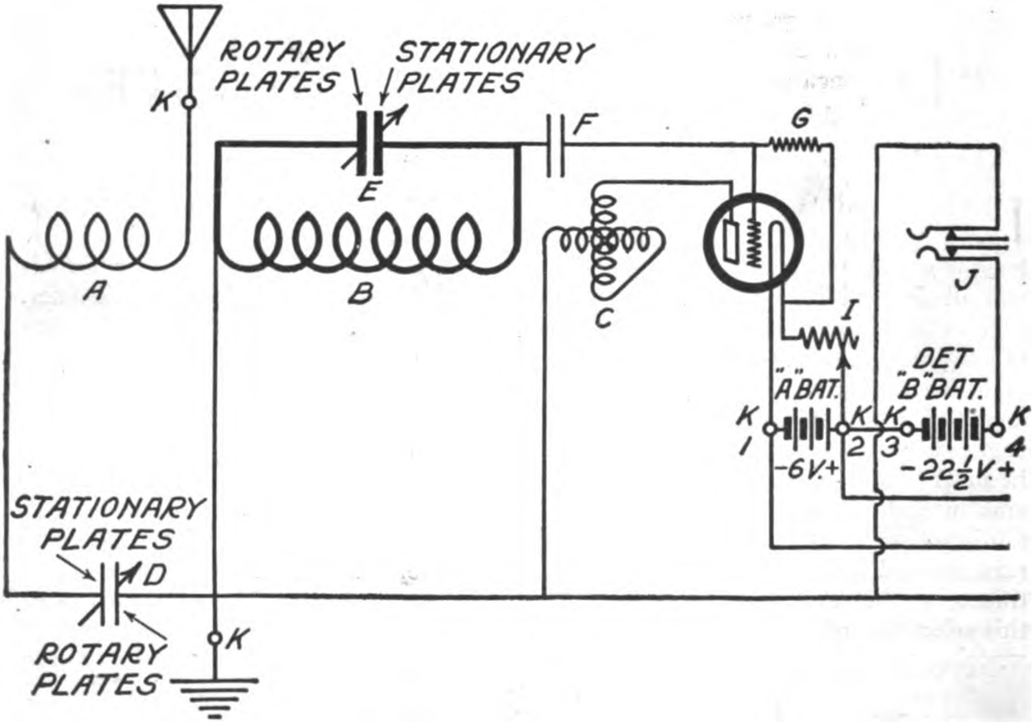
The circuit used in this set is of the triple circuit type, with an antenna circuit that responds to a large band of wavelengths at the same time (untuned). The secondary circuit is very selective, with a low decrement, and really constitutes a wavemeter which can be tuned to any definite wavelength between 180 and 550 meters. The plate circuit is coupled back to the secondary circuit in three ways:

First, by means of capacity feed-back (the old ultra-audion circuit of De Forest), in which one side of the secondary inductance is attached immediately to the plate circuit.

Second, the stator of a variometer is used as a permanent inductive feed-back.

Third, the rotor and the stator of this same variometer, which is in series with the plate circuit, are used to tune the plate circuit.

This multiple feed-back method insures stability, and allows regeneration to be easily controlled over the entire wavelength range of the set.



The coupling between the primary and secondary circuits is rather tight and fixed, eliminating the coupling control. This also allows the secondary circuit to be calibrated to wavelength; this calibration holds true, within a few per cent, for any antenna to which the set may be connected.

As the vacuum tube is a potentially operated device, this tight coupling, combined with the high ratio of secondary turns to primary turns, provides a relatively high grid voltage which results in a strong signal.

The set is completely shielded in a novel way, which prevents the troublesome effects commonly experienced from "body-capacity." This is accomplished in the set by placing the side of the instruments which face the panel at ground potential; thus the stator of the variometer is grounded and the rotor plates which are attached to the shaft of the tuning condenser are also grounded; so also is the rotor section of the so-called "vernier condenser." This is made possible by the peculiar hook-up used; the plate circuit is at ground potential, the grid and filament circuits at correspondingly higher negative potentials above ground, according to the "B" battery used.

Two stages of audio frequency amplification are included in the set and the cores of the transformers are placed at right angles to prevent magnetic coupling; the cores are also grounded. This entirely prevents any tendency toward "howling."

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below. The list of parts includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with excellent results. If other instruments than the ones listed are used it will only necessitate the use of different spacing of the holes drilled in the panel and shelf for mounting them.

A—Primary winding, consisting of 18 turns of No. 18 S.C.C. copper wire;

B—Secondary winding, consisting of 55 turns of No. 18 D.C.C. copper wire, or this coil may be wound with Liztendracht cable, which consists of 48 No. 38 copper wires, each wire convered with enamel insulation and all the wires bunched together and covered with a silk covering (A and B are wound on a composition tube, the dimensions of which are shown in Figure 3);

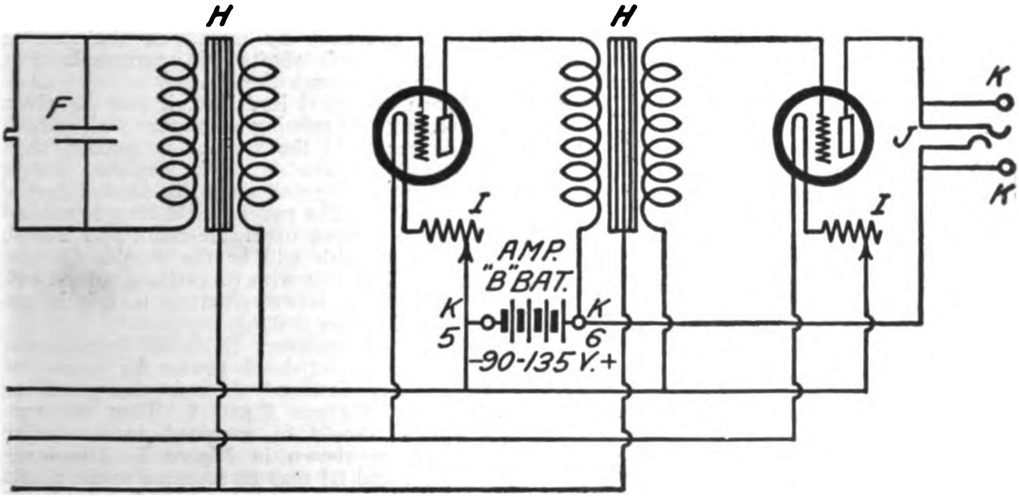


FIGURE 1

This diagram illustrates all the connections for all of the instruments required by this DX set, as well as the connections for the binding posts and batteries.

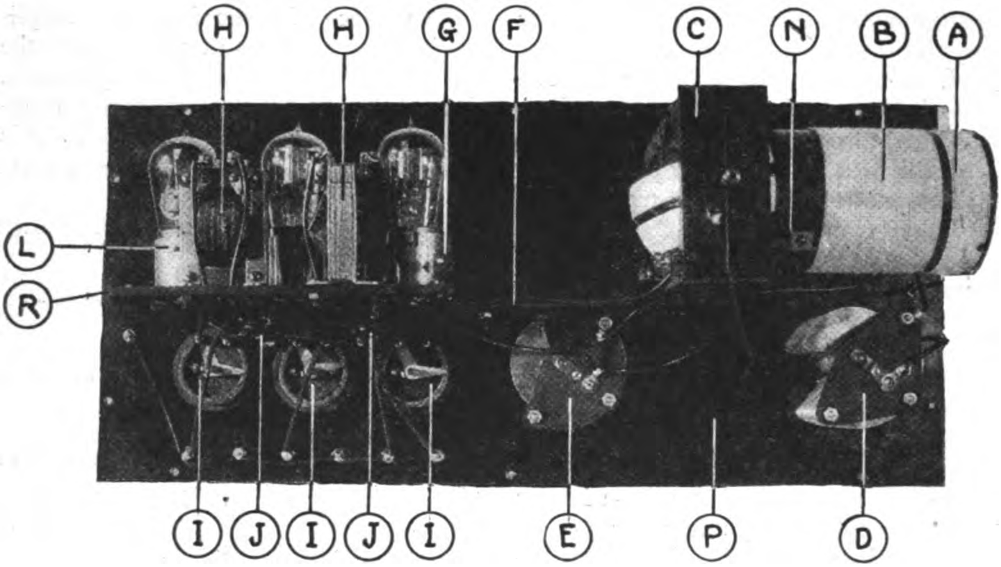


FIGURE 2

The rear view of the panel, showing the arrangement of the instruments. The various lettered parts are described in the text of the article.

C—Tuska moulded variometer;
A1, B1, C1—Tuska knobs and dials;
D—Signal variable condenser .001 mfd.;
E—Signal variable condenser .0005 mfd.;
F—Mica fixed condensers, .0003 mfd. (constructed as described in the article on page 124 of the October issue of Popular Radio);
G—2 megohm tubular grid leak;
H—Paragon amplifying transformers;
I—Fada rheostats;
J—Pacent jacks;
K—Binding posts;
L—Aluminum socket spinnings;
M—Variometer supports, brass (shown in detail in Figure 3a);
N—Brass brackets for fastening the composition tube to variometer (see Figure 3a);
O—Fada rheostat knobs;
P—Composition panel;
Q—Phosphor bronze mounting for grid leak (see Figure 3a);
R—Composition shelf for mounting tubes, amplifying transformers and grid leak (this shelf is mounted on the two jacks, J);
S—Phosphor-bronze contact-fingers for sockets (see Figure 3a);
Connecting wire No. 18 bare copper, varnished cambric tubing for insulation, machine screws, and other miscellaneous items.

How to Construct the Set

After all the instruments for building the receiver are procured, the amateur should set about preparing the panel P (shown in Figures 2, 3, 4 and 5).

First of all the panel should be cut to the correct size (10 by 22 inches); then the edges should be squared up smoothly with a file. The centers for boring the holes which are necessary for mounting the instruments should be laid out on the panel as shown in the lower view in Figure 3. The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull, permanent finish will be the result. Or, the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, the condenser D should be mounted in the lower left-hand corner by means of two screws fastened through the panel, as shown in Figures 3 and 4. Then the condenser E should be mounted in a similar manner, as shown in Figure 3. The large dials A1 and B1 may be fastened to the shafts of these condensers as shown in Figures 3 and 4. These dials are made fast by means of set screws.

The three rheostats I should be mounted

(two screws to each rheostat) in their proper places (see Figures 2, 3 and 5), and the three knobs and pointers O attached to them.

The ten binding posts K may then be inserted through the panel and fastened tight by means of the nuts on the rear of the panel, as shown in Figures 3, 4 and 5.

The next step is the preparation of the shelf assembly R. This shelf panel should be cut to the correct size (4¾ by 7½ inches), and should then have three square holes cut in it, as shown in Figure 6. These holes may be easily made by boring a hole in each corner of the square and cutting out the sides of the square with a small fretsaw; the squares may then be dressed down evenly with a small file. The eight holes for fastening the four contact fingers for each socket should be drilled and tapped for 4/32 round-head brass machine screws. The three sets of contact fingers S should then be made of phosphor-bronze (as shown in Figure 3a) and fastened to the under side of the shelf, with the square contact surfaces projecting up into the square holes (see S, Figure 3). The three aluminum socket spinnings L should then be screwed to the top side of the shelf as shown in the same figure.

Next, the two spring contacts Q should be made of phosphor-bronze as in Figure 3a, and fastened to the upper side of the shelf by means of two machine screws, as shown at QQ, Figure 3. The grid leak tube G may then be inserted in the two holes in the contacts made for that purpose.

Now mount the two amplifying transformers H with four machine screws to each transformer, making sure that the mounting flanges do not touch or make contact with the screws holding the contact fingers for the sockets.

The two jacks J should then be fastened to the shelf. As the shelf R is to be mounted on the panel P by means of the jacks J, this should be done with care. There are two screws running through the jacks which hold the jack contacts and insulating fillers in place. These two screws should be extracted and replaced, one at a time, by two screws, a half inch longer than the originals. Great care should be exercised in doing this, as the parts of the jack must not be disarranged or they may short-circuit the connections when the set is operated. The jacks are then fastened to the under side of the shelf by means of these longer screws, the extended ends of which are inserted up through the two holes in the shelf for that purpose. A nut is then screwed down over the two screw ends and the jacks held rigidly against the shelf, as shown in Figures 3 and 5.

The whole shelf assembly may then be mounted on the panel P by screwing on the hexagon nuts that form the front portion of the jacks. The correct spacing and position for this shelf will be automatically assured if the jacks are fastened into the two holes drilled for them in the panel P as shown in the layout for this panel in Figure 3.

Further efforts should now be directed

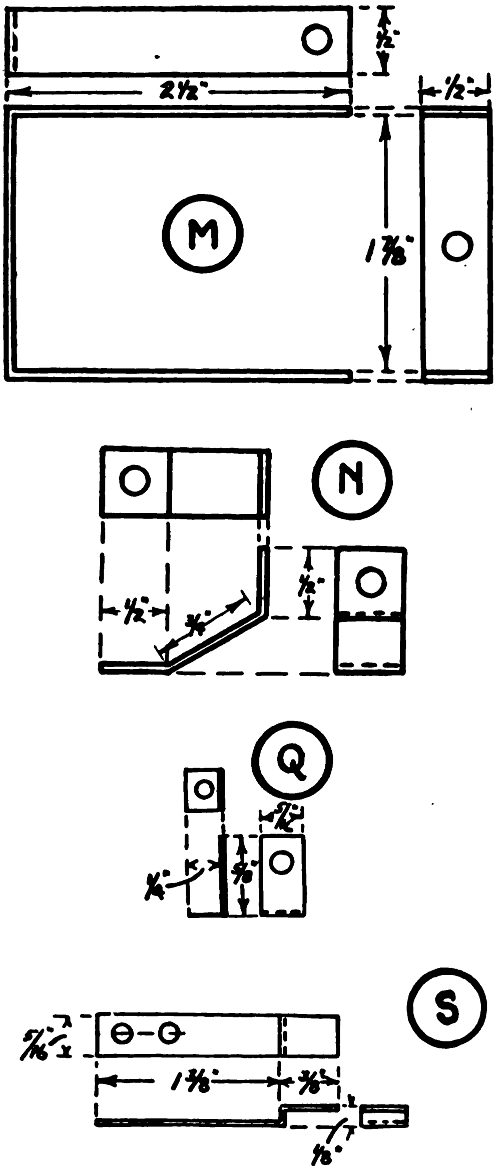


FIGURE 3a

This diagram gives the dimensions of the metal brackets and contacts, and shows the correct shapes for bending. Pieces M and N are of 1/16-inch brass. Pieces Q and S are of springy phosphor-bronze. Two of M are used for mounting the variometer, two of N for the coil tube, two of Q for the grid leak, and twelve of S for the sockets. The sizes of the holes to be drilled are determined by the screws used. The parts should be carefully made and bent or the instruments will not be securely mounted.

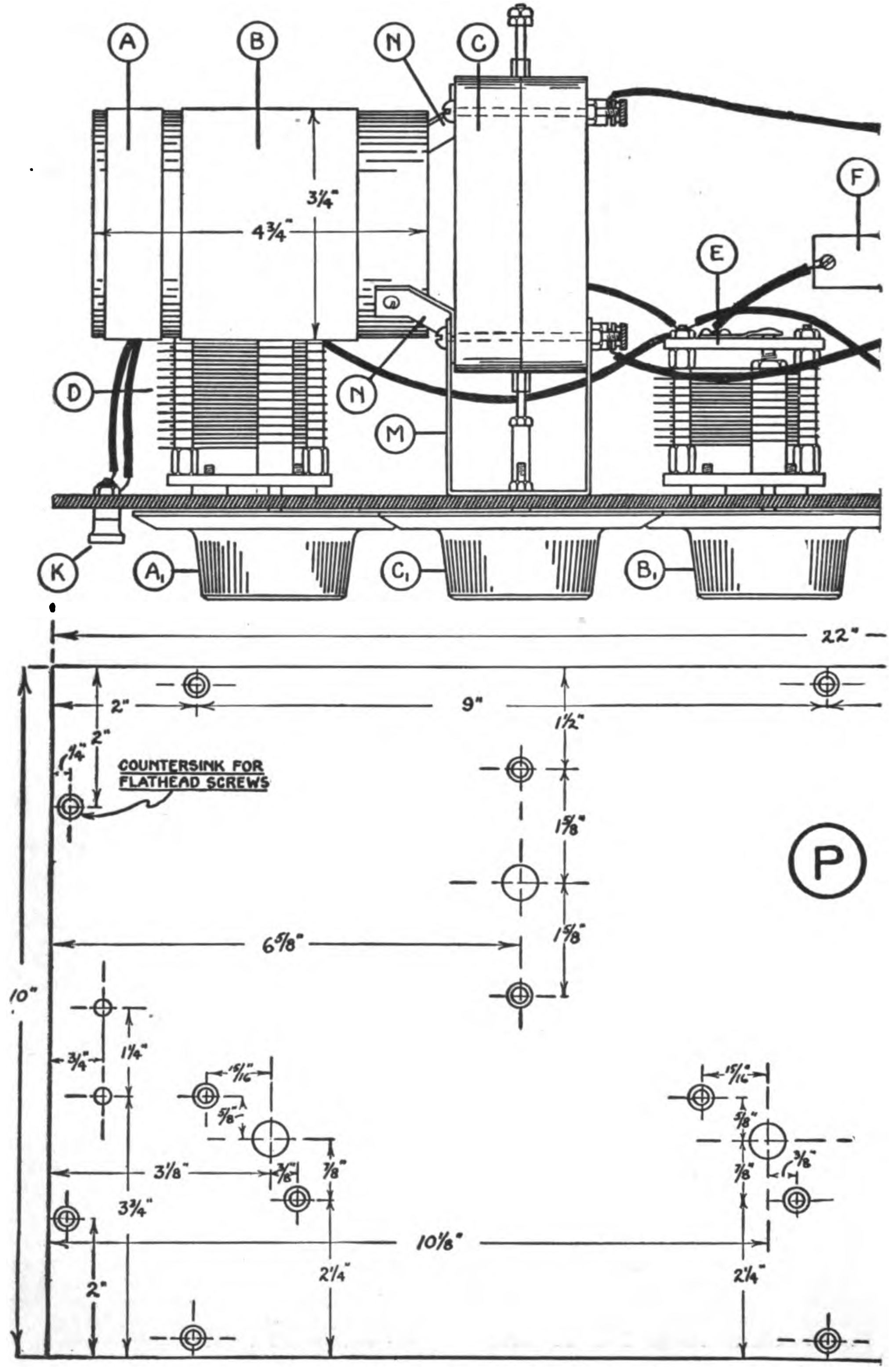
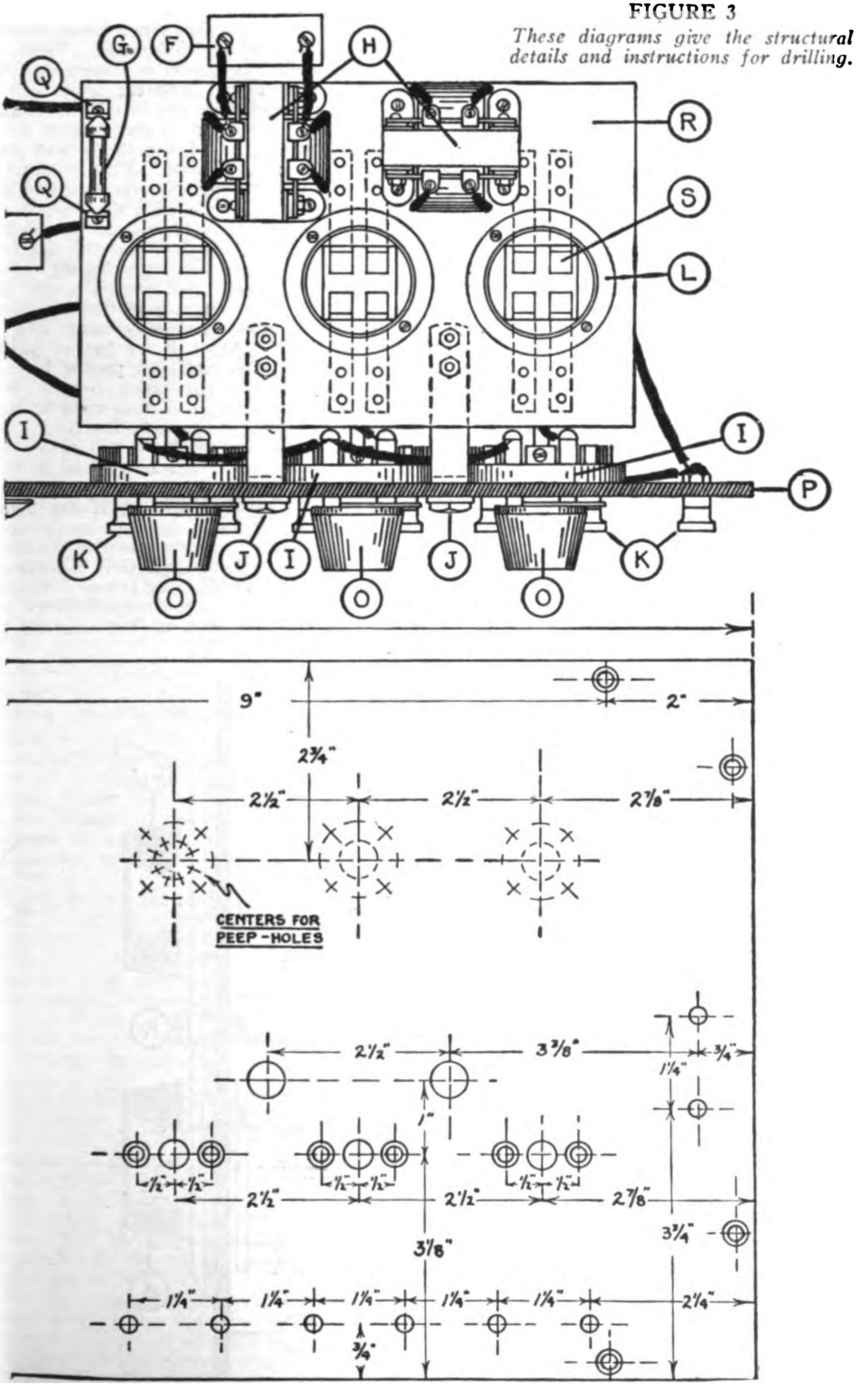

A
B
N
C
3¼"
4¾"
F
E
D
N
M
K
A_1
C_1
B_1
22"
2"
9"
1½"
2"
¼"
COUNTERSINK FOR FLATHEAD SCREWS
1⅝"
P
6⅝"
1⅝"
10"
1¼"
¾"
15/16"
5/8"
3⅛"
3/8"
7/8"
3¾"
15/16"
5/8"
7/8"
3/8"
10⅛"
2¼"
2"
2¼"

FIGURE 3

These diagrams give the structural details and instructions for drilling.



toward the construction and assembly of the tuner elements consisting of the coils A and B and the variometer C.

Let us start by cutting the insulating tube, which is 3¼ inches outside diameter, to a length of 4¾ inches. Bore a small hole in one end of this tube, one-eighth of an inch from the end, just large enough to pass the No. 18 single cotton-covered copper wire, and thread one end of the wire through the hole, and proceed to wind on the tube the 18 complete turns that constitute the primary coil A. Another hole is then bored at the finish of the winding, and the wire threaded through it, and a six-inch lead brought out through the center of the tube. One-quarter of an inch farther on beyond this last hole, another hole should be made for the start of the secondary winding (coil B). For this coil wind on, in the same spiral direction as the coil A, 55 turns of wire and finish off in the same manner as with coil A. If the "Litz" cable is used for this coil, slightly better results will be obtained in both tuning and signal strength. The results obtained with the ordinary solid copper wire, however, will be almost as good, due to the use of the regenerative circuit, which tends to decrease the resistance of the coils, thus doing away with the losses in the circuit. Now make the brass brackets according to the dimensions as shown at N in Figure 3a. These should be fastened to the tube by means of short machine screws and nuts (see Figures 3 and 4).

We can now set the tube aside for the time being and make the two large brass brackets M for mounting the variometer. These are bent and drilled as shown in Figure 3a. The two long screws that hold the front half of the variometer together are then extracted, the two brackets are placed in the position shown at M in Figures 3 and 4, and the bottom screw is put back and tightened. The bottom rear screw that runs through the variometer is then taken out and the tube with the coils A and B wound on them is placed in the position shown in Figures 3 and 4, and the top front screw and the bottom rear screw of the variometer inserted through the brass brackets, thus fastening the tube securely to the variometer.

The whole tuner assembly may now be mounted on the panel P by means of two screws inserted through the proper holes in the panel, and the two holes in the brass brackets M. The knob C1 may then be tightened on the shaft of the variometer.

The construction work on the set is now completed except for the mica condensers F, which may be purchased. The capacity of each is .0003 mfd. However, if the builder wishes to make them, he may easily do so by following the directions given in the article, "How to Make Your Own Grid Condenser," on page 124 of the October issue of POPULAR RADIO. It is better to use mica-dielectric condensers than paper ones, as their capacity does not vary as much.

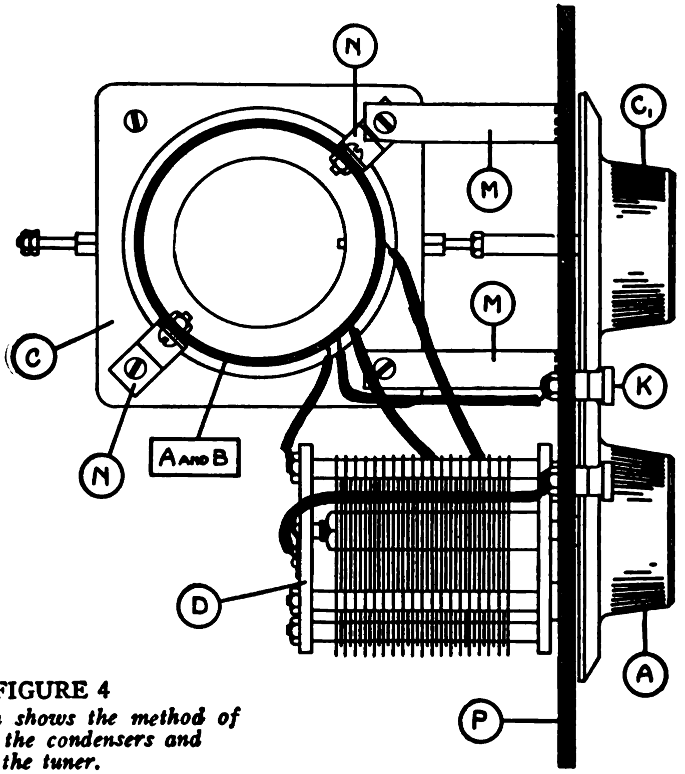


FIGURE 4
This diagram shows the method of mounting the condensers and the tuner.

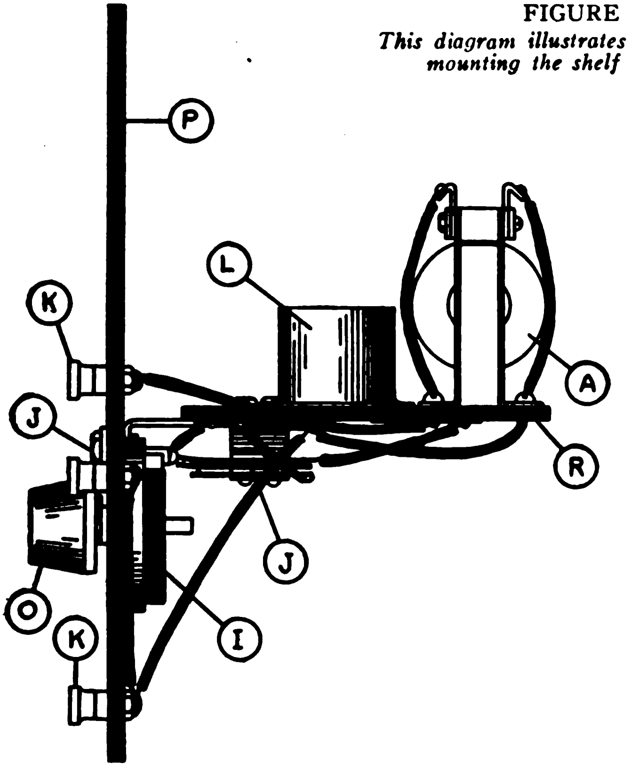


FIGURE 5
This diagram illustrates the method of mounting the shelf of the set.

How to Wire the Set

Before we start to wire it may be well to first consider just what the "wiring" accomplishes or is meant to accomplish in a radio receiver. Many radio fans who make their own sets breathe a sigh of relief when they finally get the instruments mounted.

"All I have to do now," they say, "is to wire it up."

So they get out the diagram and proceed to do just that thing, running all the wires nice and straight, with beautiful square turns and corners, like a lot of lighting cables running underground, up one street and around the corner, bunched together in a fine workmanlike way. When the set is finished the wiring sometimes looks so beautiful that the builder dislikes to put the set into a cabinet; it "looks too pretty."

This is foolishness. Many a set, with this square bus-bar wiring which looks so neat, works poorly, because the wiring does not accomplish the purpose it is supposed to. The wiring is supposed to so harness the different instruments in their proper electrical places that they will all pull together for a given purpose. The wiring of a radio set bears the same relation to the set that the tracings and reins of the harness do to a horse and buggy, or that the steering gear and propelling gear do to an automobile. We must not mix up the reins (which control the horse) with the traces (which transmit the motive power or energy); we must not get the steering gear of the automobile mixed up with the propelling apparatus or the results will be disastrous. Likewise we must keep the control-circuit wiring of a radio set separated from the energy circuits; in other words, the grid leads, which control the vacuum tube circuits, should not be run parallel or close to the filament or plate energy circuits. Keep them as far away as possible.

Another point to remember: If you happened to be walking through a section of town which was not built up as yet, and your destination could be reached much more quickly, and with less expense of energy, by cutting across lots in a "bee-line," you certainly would do so if "the going were good."

Make the "going" good for the electrical currents flowing in your radio set by using bee-line wiring. When you connect two instruments with a wire, do it by the shortest path—unless this would interfere with the rotation of some moving part, or would bring two leads of a control circuit and an energy circuit, respectively, too close to each other.

Do not use too large a size of wire for connections; No. 18 is plenty large enough to handle any of the currents flowing in a receiving set without any dangerous rise in temperature and a corresponding rise in resistance. If larger sized wire than this is used, the capacity between two parallel wires may be high enough to interfere with the proper functioning of a circuit, and the little imaginary condensers thus formed will in reality act as numerous filter circuits in your set and will filter out and weaken your signals.

Each connecting wire may be covered with varnished-cambric insulated tubing. Solder all connections when you have tested out the set and determined that they are all correct, and thus eliminate chances that the set may become "noisy."

Is there anything else to be said in the way of advice and admonition? If there is it is this: "Think well, before you connect, and check well after you have connected, and you will hear well when the set is finally put in operation."

Start wiring the filament circuits of the three tubes in the set; when this is complete, wire up the condensers and tuning coils A and B, first the antenna circuit and then the secondary circuit; then wire the variometer and the plate circuit of the first tube, including the "B" battery connections, the jack, and the primary winding of the first amplifying transformer. When this is done, commence with the plate and grid circuits of the first stage of amplification, including the primary winding of the second amplifying transformer. This leaves only the grid and plate circuits of the second stage of amplification to be finished and the wiring will be completed. The diagram for connecting the set is shown in Figure 1. If the wiring scheme as outlined above is kept in mind, while referring to the diagram for the correct connections, the job should be a comparatively simple one.

A cabinet for the set may be made of wood (mahogany or oak) according to the dimensions given in Figure 7, but we will not go into details concerning it here.

Operating Data

In connecting this set, the following hints may be of value:

The set may be used with almost any type of antenna with a horizontal length of over 75 feet. This should be connected to the top left-hand binding post shown in the illustration on page 35.

The ground is connected to the lower post at the left.

The negative "A" battery terminal is connected to the first post at the bottom of the set (counting from the left).

The positive terminal of same battery is connected to the second from the left.

The third post is for the negative "B" battery, for the detector plate.

Number four is for the positive "B" battery, for the detector plate.

Number five is for the negative "B" battery for the amplifier plates.

Number six is for the positive "B" battery for the amplifier plates. (Note that two separate "B" batteries are used, one for the detector tube, about 22½ volts, and one for the amplifier tubes 90 to 135 volts).

The two binding posts mounted vertically at the right should be connected in shunt to the last jack, and are used for additional connections for telephones or for a loudspeaker.

To set the receiver into operation insert the plug attached to the telephones into the first jack and light the filament of the first tube to the correct brilliancy by rotating the first left hand small rheostat knob O. This will allow reception with the detector tube, without the use of amplifiers.

If a louder signal is required (such as for operating a loudspeaker), the plug should be inserted in the second jack, and all three knobs O should be adjusted for the proper filament current for the three tubes.

All tuning is done with the three larger dials A1, B1, and C1. The vernier tuning dial A1 should be placed at approximately 75, and the regeneration dial C1 at O, and the

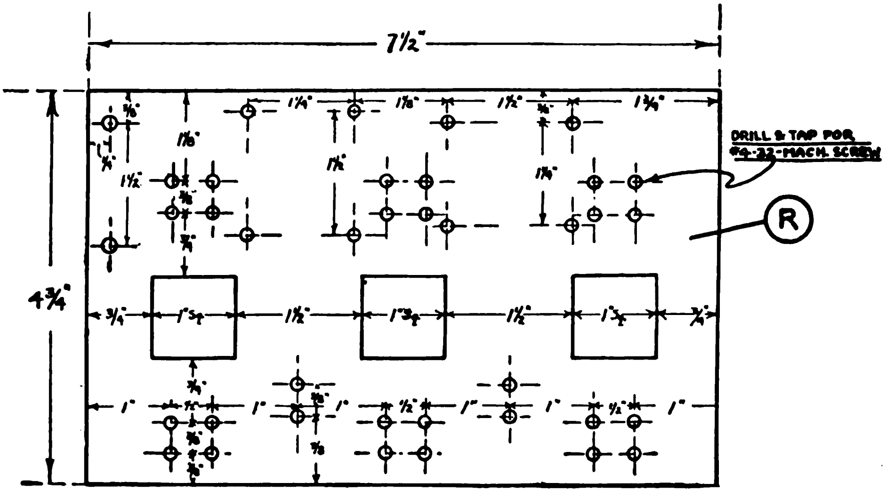


FIGURE 6

This diagram shows the layout for preparing the shelf, with proper spacing for drill holes.

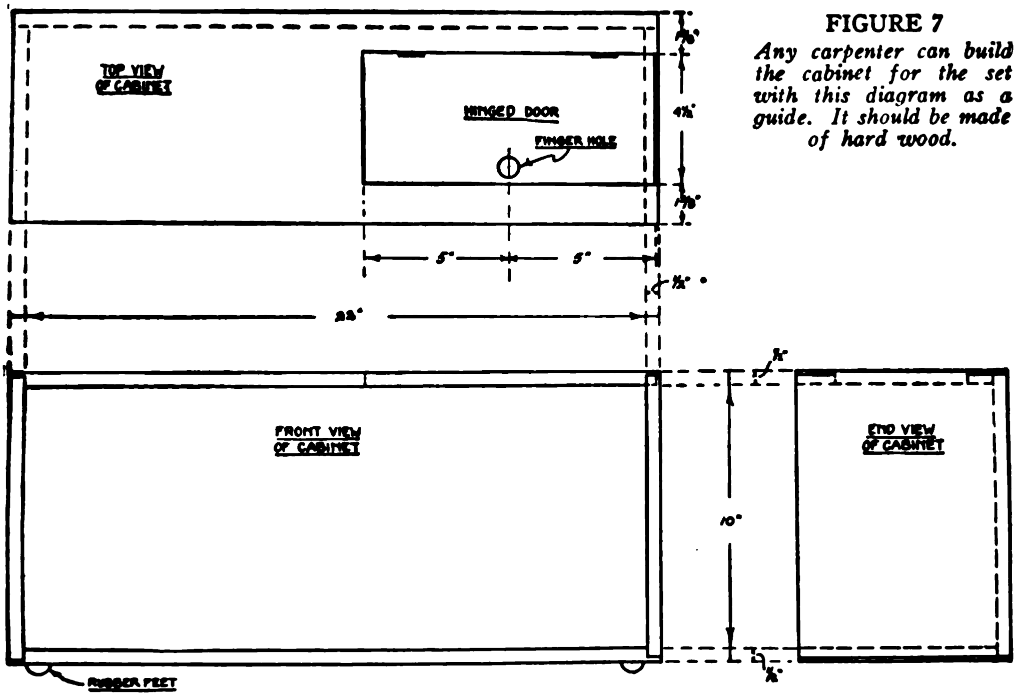


FIGURE 7

Any carpenter can build the cabinet for the set with this diagram as a guide. It should be made of hard wood.

main tuning dial B1 at O. This will correspond to a wavelength of about 180 meters. If the listener wishes to listen to amateurs he should rotate the dial B1, very slowly, between O and 20. This dial should be handled with care or the signals will be passed over, as the tuning is so sensitive that two amateur stations may be tuned in and out in one degree on this scale. Then when a signal is heard, the dial C1 should be slowly rotated until the signal is increased in strength sufficiently without the tube starting to oscillate; it may be turned only so far, for a given wavelength, then a click and a mushy sound will be produced which will blot out voice signals and spark. The final delicate tuning is accomplished by turning the vernier control dial A1 in one or the other direction for the loudest results that can be obtained with clarity.

For broadcasting reception on 360 to 420 meters, the same general rule for tuning holds true, except that the dial B1 must be rotated until somewhere between 35 and 45; the same procedure is gone through as outlined above with the regenerative dial C1. It will be found that the higher the wavelength employed, the more regeneration will be required to bring the set to the oscillating point. Too much regeneration will cause distortion.

For listening to C.W. signals the dial C1 is rotated past the oscillating point, and the dial B1 rotated until the beat note is picked up, when it may be tuned in strong with the vernier.

When this set is constructed properly, and the operator becomes familiar with the method of tuning, amateur and broadcasting stations from all over the country may be tuned in clearly with little or no interference.

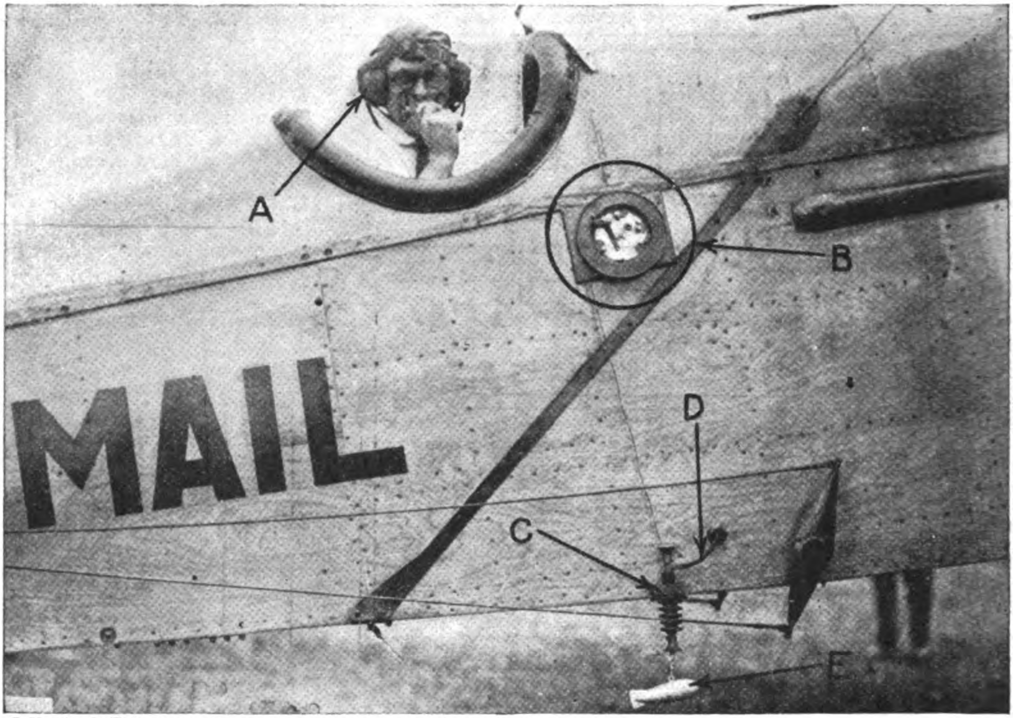
Photo made for POPULAR RADIO

What Educators Think of Radio

To the Editor of Popular Radio:

"You may be sure that the Bureau of Education of the Department of the Interior will be glad to co-operate to the extent of its ability in the broadcasting program which you are planning."

L. A. Kalbach
Chief Clerk, Bureau of Education



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THE FIVE FEATURES OF THE NEW INSTALLATION

A is the soundproof head-gear which contains the sensitive receivers; B is the automatic reel containing the antenna wire; C is the insulating bushing through which the antenna wire is led out when the plane reaches a suitable height; D is the lead-in-wire to the radio apparatus, and E is the leaden weight which holds the antenna wire taut while flying.

A Mail Plane Guided by Radio

By RICHARD LORD

IF the experiments now being carried on at Bolling Field, Washington, D. C., prove successful, the Air Mail Service of the U. S. Post Office Department may install radio telephone sets on all its planes and start a "night flying" schedule. There are a number of problems that must be solved, however, before such a program can be effective.

In the installation itself, the head-telephones and the mouthpiece have to be soundproof to keep out the roar of the motor; an outfit of this type is shown in the illustration. Also the ignition of the motor (each spark plug and coil is a radio transmitter) must be shielded, to prevent the voice from being drowned out; this is accomplished by running all the ignition wires in metal conduit or metal braided wire.

A suitable antenna system for aerial use had to be devised that would not interfere with the flying controls and which would not be in the way while the plane is making a landing. The type selected consists of a reel (something like a large fish reel) attached to the side of the fuselage, fitted with a handle and ratchet and containing about 300 feet of flexible wire. The wire is led down through an insulating guide bushing and may be unreeled when the plane has reached a suitable height, and re-reeled when the plane reaches a point above its destination and the operator begins his preparations to descend.

A ground is made by fastening to the metal parts of the plane.

Other problems connected with night flying are: The determination of direction; means of communication between ground stations and planes in flight to warn the flyer against storm centers he might be unknowingly flying into; and a means by which the flyer might advise the nearest route station of trouble with the craft. Radio offers a possible solution to these problems. In each of the fifteen radio stations of the U. S. Post Office, there could be installed a direction finder, by means of which the land stations may advise the flyer of his position and aid him to get back "on the track" if he should be forced off his course by a storm. These sets, furthermore, enable the land station to determine the position of the craft in case of trouble with the machinery, so that the nearest depot could rush mechanics to the scene for repairs.

If the scheme works with anything like the success that is predicted for it, a wide extension of the mail service may be looked for.

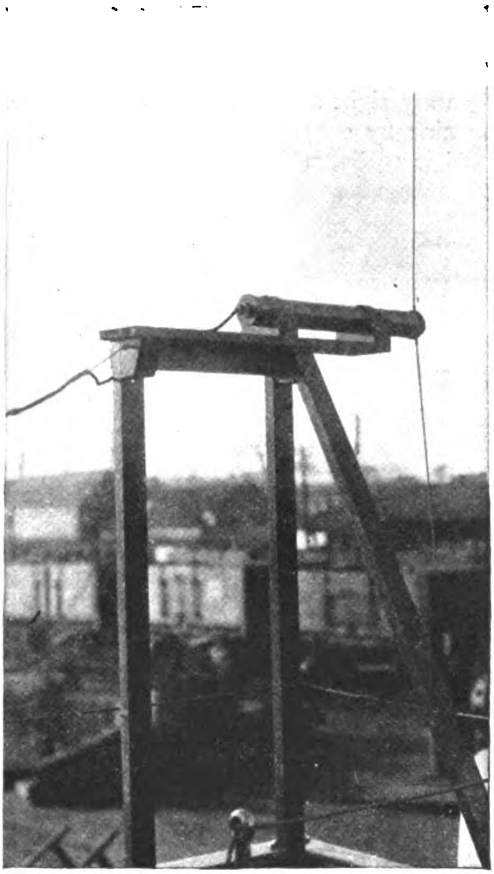
A New Kind of Radio Lighthouse

By STEPHEN LEE

A LIGHTHOUSE that sends out invisible beams, that will probably replace the old time lighthouse and has a greater range, has just been completed on Inchkeith, an island in the Firth of Forth, Scotland. This new lighthouse replaced a smaller experimental one at the same place, after tests between it and the *S.S. Pharos* had been completed.

The "beam" that is sent out by this revolving lighthouse (which, by the way, would never be recognizable as a lighthouse by an old mariner) is a radio wave of very short wavelength, 4.28 meters, which is focused in one direction much in the same way that a beam of light is focused along the road by an automobile headlight.

The lighthouse consists of a steel frame, reminding one of a revolving clothesline hanger, except that there is another series of arms placed near the ground. The wires which form the reflectors are stretched between these two series of arms as shown in the illustration. The receiving antenna and apparatus as used on shipboard are shown in the picture on this page.



From a photograph by P. J. Risdon, London

A NOVEL ANTENNA

The arrangement of the aerial installed on the bridge of a ship. This is the type of antenna that receives the 4.28 meter wave sent out by the radio lighthouse.

The method provisionally adopted for giving bearings to a ship is as follows:

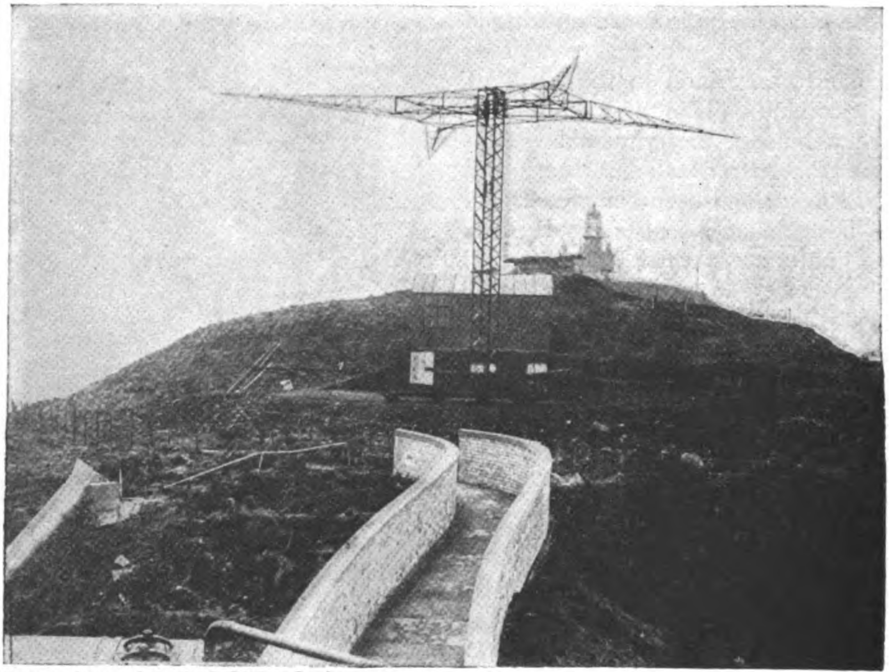
On the base of the revolving lighthouse or reflector are arranged a number of contact segments that cause a short signal to be sent out at every quarter or half point of the compass. The reflector revolves one revolution every two minutes. A distinctive letter is sent out at every two points of the compass. In this way a ship may know at just what particular instant the lighthouse is sending out a ray in a specified direction.

The beam is so directional that at a distance of four miles signals are heard from the reflector for only seven seconds out of each minute; at greater distances this time is reduced. However, the exact time of maximum intensity, indicating the instant when the beam is pointing right at the ship, is hard to determine by ear; accordingly the method used is to listen for the start and finish of the signals, which is easily recognized. The time half way between these two intervals gives with exactitude the moment that the beam is pointing at the ship.

The mariner then consults his chart and determines what direction the letter heard at this instant corresponds with, and thus is enabled to get his bearing.

This system is destined to come into extended use, as any number of ships may get bearings at the same time without waiting their turn, as is the case with the system employed in American waters.

There is one shortcoming in this method, however: there is no way of determining how far distant the ship is from the lighthouse. This shortcoming may be easily overcome by taking observations from two lighthouses in different locations at the same time, by means of two receivers on board ship. The correct position of the ship may then be plotted on a chart, the position being the point where the two lines (indicating the direction of the two beams) meet on the chart.



From a photograph by P. J. Risdon, London

A REVOLVING "RADIO BEAM" PROJECTOR

This unique radio apparatus has taken the place of the old-fashioned lighthouse at Inchkeith, Scotland. No matter what the weather is this new marvel of science gives accurate bearings to the vessels at sea.

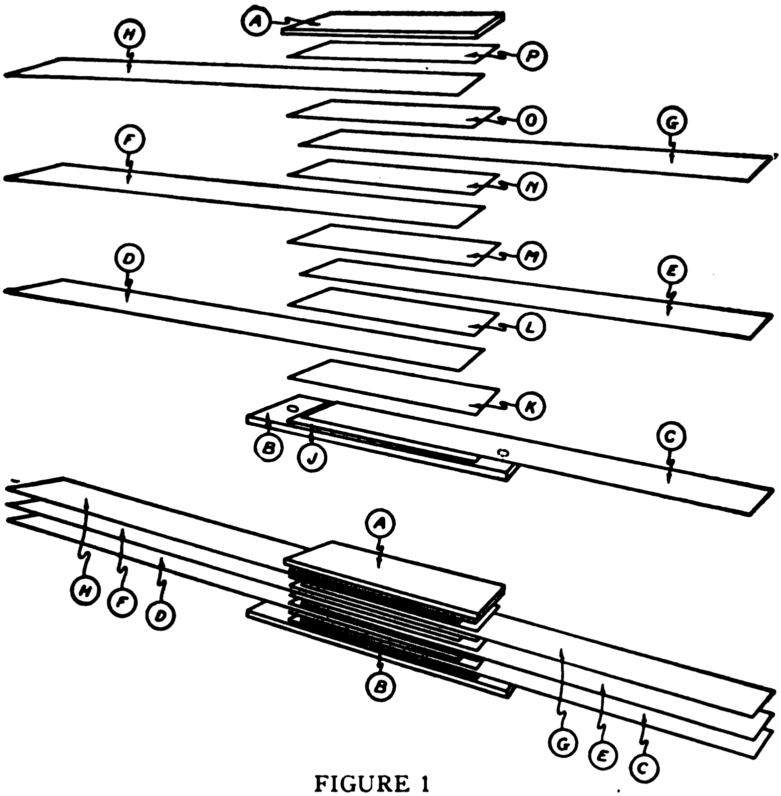


FIGURE 1
The parts of the condenser should be assembled in the order shown on this diagram—reading from top to bottom.

How to Make a TELEPHONE CONDENSER

A Simple Device for Increasing the Efficiency of Your Set—at a Cost of 30 Cents

By WATSON DAVIS

THE interest that Uncle Sam is taking in his large and rapidly growing body of radio enthusiasts is being demonstrated in essentially practical form. Through the Radio Laboratory of the Bureau of Standards he is experimenting with the "one best way" of making the various parts of radio apparatus that the amateur may make at home at trifling expense; indeed, the receiving sets which have already been developed (as well as the various auxiliary parts) have enabled thousands of novices to participate in the broadcasting programs and have stimulated an interest in the radio art that is leading to far-reaching results.

The latest apparatus developed by the Bureau of Standards is a telephone condenser—which any novice may make at home for about 30 cents. It may be attached to the receiving sets previously described in detail in POPULAR RADIO. The effect of the telephone-shunt con-

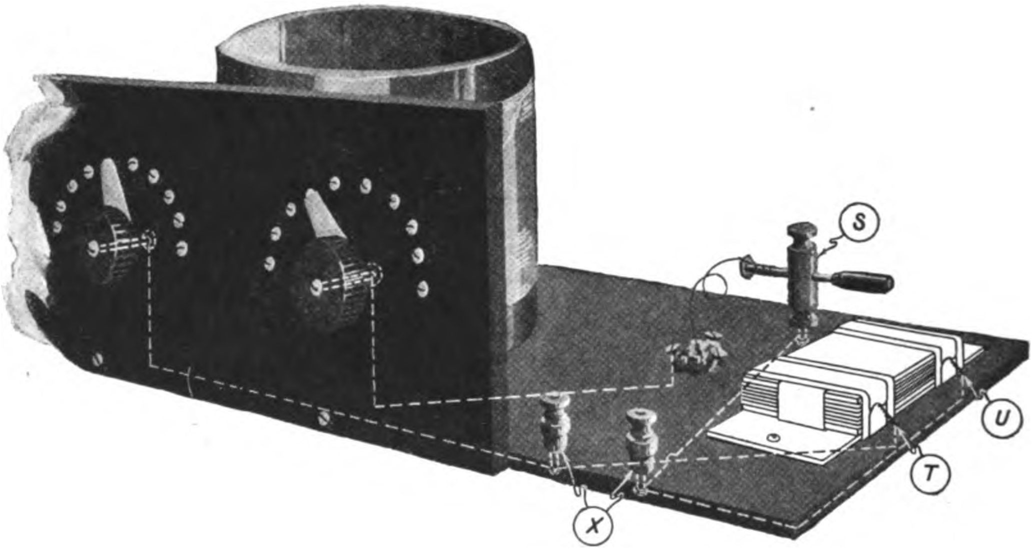


FIGURE 2

The telephone condenser may be connected to the single circuit receiver by connecting the two terminals, U and T, to the two binding posts of the set, marked X in the above diagram. The wiring may be done on the under side of the board, as indicated by the dotted lines, thus both making a neater appearing set in which the wires are out of the way and also keeping the connections from becoming broken.

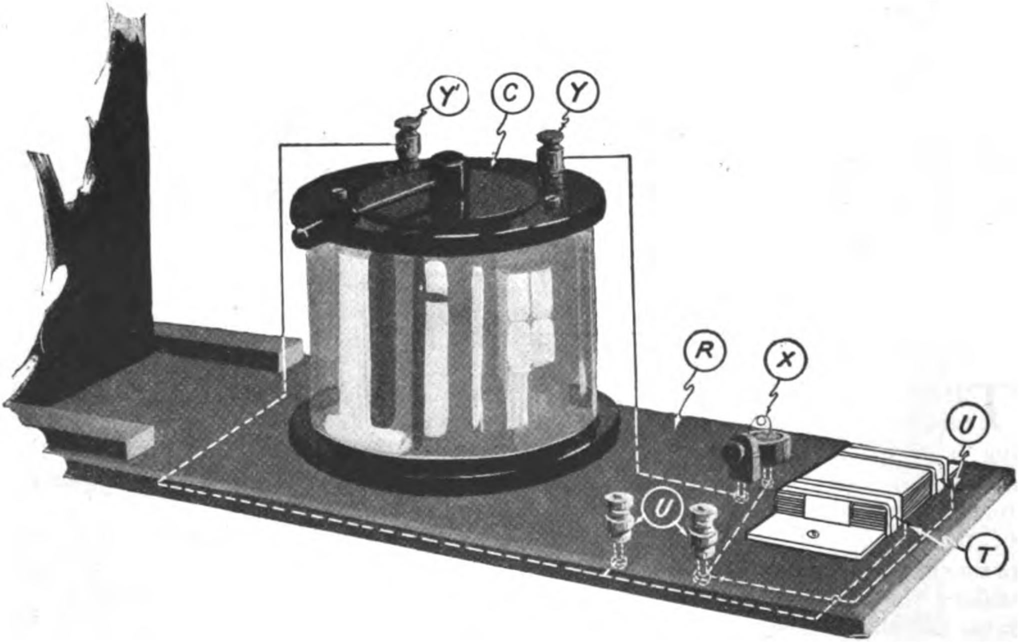


FIGURE 3

In this illustration the two terminals, U and T, are shown connected to the two binding posts marked U on the double circuit receiver. But a telephone condenser may be used with any set, provided it is connected in shunt with the telephone terminals. The effect of such a condenser is to pass the radio frequency impulses around the telephones and to act as an accumulator for the audio frequency voltages.

denser is to increase the intensity of some radio signals to which the receiving set may be tuned. In most cases the use of this condenser has no effect upon the intensity of signals which are received from a radio telephone transmitting station, but will increase the intensity of radio signals which are received from most spark transmitting stations. The telephone-shunt condenser described below has a capacity of approximately 0.0015 microfarad (1500 micromicrofarads).

How to Build the Condenser

The parts used in the construction of the condenser are: a cap piece of heavy pasteboard or wood, A, about 1⅜ by 3 by ⅛ inches, a similar base of pasteboard or wood, B, 1⅜ by 3⅞ by ⅛ inches, six pieces of tin-foil, C, D, E, F, G, H, ⅞ by 7 inches, seven pieces of paraffined paper or mica, J, K, L, M, N, O, P, 1⅛ by 3 inches, one stiff paper clip or its equivalent (for temporary use), about 10 feet of No. 24 bare copper wire, and two round-head wood screws about ½ inch long.

The several steps in the arrangement of these parts are shown in Figures 1, 4 and 5. The layers of paraffined paper and tin-foil are alternated as shown, starting with a sheet of paraffined paper on the Base B. The paper J is placed in the center of B so that there will be a ⅛ inch margin at the sides and 7/16 inch margin at the ends of B. A sheet of tin-foil C is then placed on the paper J so that there will be ⅛ inch of margin of paper uncovered on three sides. The tin-foil C will then extend 4⅛ inches over the right-hand edge of the paper J, or 3 3/16 inches over the right-hand edge of the base B. The paraffined paper K is placed on C directly above J. The tin-foil D is placed on K. The overhanging end of D extends to the left instead of the right as did C. The other three sides of D are ⅛ inch in from the three edges of K. This arrangement of alternate layers is followed until the seven paraffined papers and the six sheets of tin-foil are placed in position. The cap piece A is then placed as shown in Fig. 1.

The condenser now appears as shown in Figure 1, except that the thickness of the condenser is much exaggerated here in order to better show the parts. A paper clip or other form of temporary clamp may be used to hold the parts firmly together. The tin-foil strips, D, F and H, are now bent back over the end of the cap piece A and folded over at an angle of 45 degrees (see line RS, Figure 4) so that the tin-foil may be wrapped evenly around the pieces A and B and secured by several turns of No. 24 bare copper wire. (See Figure 5.) The tin-foil strips C, E, and G (Figure 1) are wrapped in the same manner. The completed condenser appears about as shown in Figure 5, except that it is much thinner. The drawing has made the apparatus appear much thicker than it will appear in reality, in order to show the details of construction more clearly.

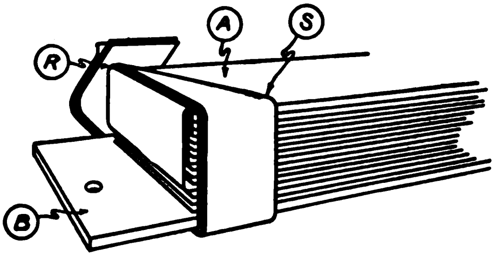


FIGURE 4

How to wrap the tin-foil strips around the ends of the condenser preparatory to securing with the binding wires.

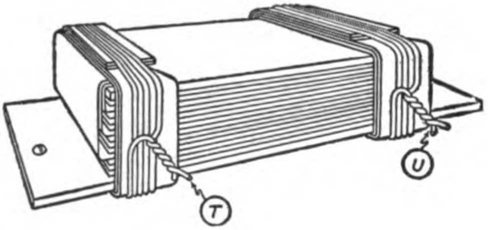


FIGURE 5

How to secure the binding wires which also form the two terminals, U and T, of the condenser.

This telephone-shunt condenser just described may be added to the single-circuit receiving set described in the May issue of POPULAR RADIO or to the two-circuit receiving set described in the July issue. The condenser is placed as shown in either Figure 2 or Figure 3. A somewhat simpler plan is to screw the condenser to the underside of the receiving set baseboard; this saves drilling more holes in the baseboard in order to keep the wiring on the underside. No matter with which receiving set this condenser is used, the two wires T and U (Figures 3 and 2) are connected to the two telephone receiver binding posts marked "Phones."

Fixed condensers may be purchased which will give about the same results as those herein described, but it is more fun and much more instructive to build your own.

The Costs of the Parts

The itemized costs of the telephone shunt condenser are computed as follows:

About 40 square inches of heavy tin-foil..	$0.25
2 screws for mounting condenser......	.05
2 small pieces of heavy cardboard or thin wood	
Paraffin	
Paper	
Total cost......................	$0.30

¶ Two notable achievements in the broadcasting of athletic events took place this fall. This article tells how they came about.

→

Here is Popular Radio's *press box at the Polo Grounds, New York—from which reports of the big footbal games were broadcast while the plays were still in progress.*

FOOTBALL *by* RADIO

By GEORGE B. CHADWICK

To maintain broadcast programs on such a high level of excellence that they will command the attention of the radio fan is the most immediate problem before the radio industry today.

The interest of the radio fan is centered, not in the receiving set itself, but in *what he will hear on it.*

It is becoming increasingly difficult to induce eminent musicians and lecturers to come to the broadcasting stations. It is becoming correspondingly necessary to tap those auditoriums, lecture halls and athletic fields where entertainment is provided. To tap these points, so that the entertainment may be transmitted to the broadcasting stations, requires land wires. The problem thus resolves itself largely into the problem of obtaining wires.

During the football season just closed this problem was solved in two ways:

First—The American Telephone and Telegraph Company performed the remarkable feat of broadcasting from the New York station, WEAF, side-line reports of football games held in Chicago, thus demonstrating that the technical obstacles can be overcome.

Second—Sideline reports of the football games at the Polo Grounds in New York (broadcast by Popular Radio) were sent out from Westinghouse station WJZ in Newark with the aid of Western Union wires—thus demonstrating that telegraph lines can be used as well as telephone lines.

How these two experiments were successfully made is told in this article.

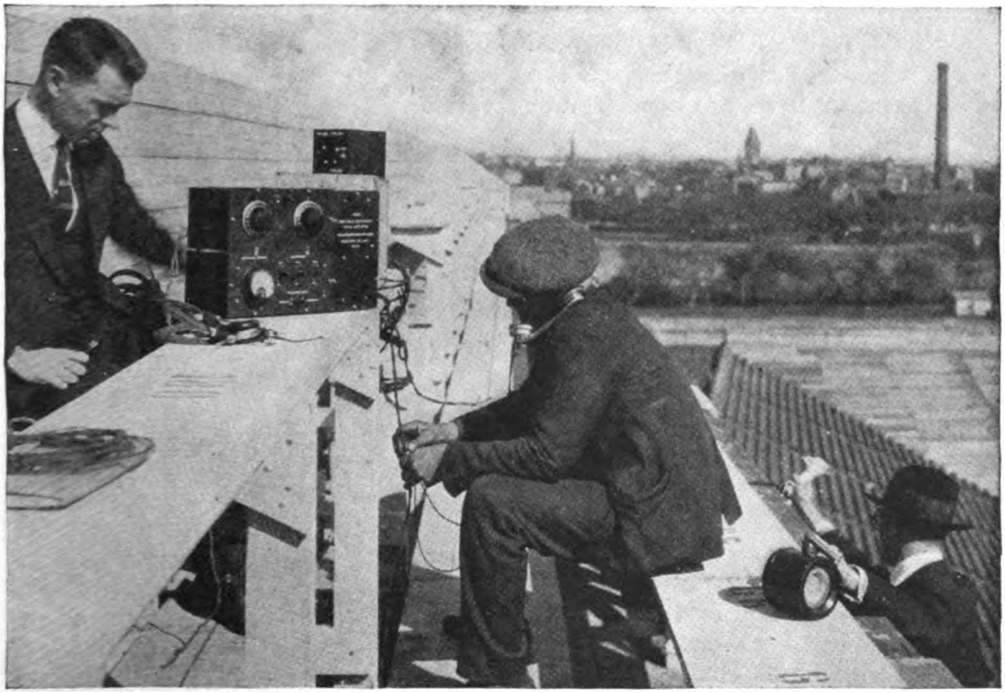
—Editor

TIME was when the "old college grad" in a distant city hied himself to a telegraph ticker and waited for the returns of the big football games as they came over the wire, in short colorless messages. There was eagerness in his gaze, perhaps an attempt to catch from the face of the announcer an inkling of what had happened before he read the message aloud. But if the old grad had a touch of the philosophical in his makeup, sometimes there came the deadening thought, "All this took place minutes ago. If I only knew what is happening *now.*"

Today the old grad is—aurally at least—transported to the ball field by radio. He knows when No. 8 is still running down the field with the ball; he can hear the shouts of the grandstands. He knows at the instant when No. 8 is tackled by No. 51 of the opposing team. He hears the rhythmic cadence of organized cheering, the actual music of the bands; in a momentary lull he catches the harsh crackle of a sharp-voiced quarterback. And he hears it all in company with a multitude of people scattered over half a continent.

A few years ago the crowds that attended a mid-season game amounted to a mere thousand or two; only the few big games drew as many as 30,000 to 35,000 people. Today, however, even mid-season games draw as many as 75,000.

There is significance in these two facts: The instant reporting by radio of a great national sport; the multitude of interested people, both those who gather in great crowds to see the games and those who have not been able to attend but who can listen in at home or gathered in a hall or around a curb where there is a loudspeaker. It is the handwriting on the wall; we get a glimpse into the future, of one of



Amrad

HOW THE GAMES IN THE HARVARD STADIUM WERE BROADCAST

The microphone and the voice amplifier were located in a press box on top of the Stadium. Telephone wires connected this apparatus with WGI, four miles distant.

the big things that radio is beginning to do.

No longer are people merely interested in the mechanism of a new device and willing through curiosity to listen to any program that is broadcast. They want entertainment that comes to them direct from the great stadiums, athletic fields, auditoriums and concert halls.

In line with its policy of promoting the broadcasting of events of widespread popular interest, POPULAR RADIO sponsored the broadcasting of the series of four great football games played at the Polo Grounds in New York this fall.

Up in the second tier of the Brush Stadium, in Box 24, located on the south side of the field and almost exactly opposite the 50 yard line, was installed the radio apparatus — the amplifier cabinet with necessary "A" and "B" batteries for the tubes, and two microphones. One microphone picked up the music and cheers on the south side of the field, the other microphone transmitted the voice of the announcer. From this box was run 1000 feet of cable to the north stands to connect with a third microphone, placed in front of the cheering section there at a height of about six feet.

The next essential was a proper land-wire connection with the Westinghouse broadcasting station, WJZ, at Newark. Here the Western Union played its part.

A telegraph circuit was hooked up connecting the amplifier in Box 24 with the terminal board at Harlem River. From this point a pair of regular telegraph wires direct to Newark was used. To make sure of a good connection, and to cut out any extraneous noises, the Western Union had previously checked over their wires; indeed, this had been done before the World Series of baseball games, and the same pair was used for the football contests. The Western Union also conducted tests to make sure that regular traffic going over other nearby wires would not disturb or interfere with the operation of this special circuit, and arranged its traffic during the broadcasting period accordingly. Thus the way was carefully made ready, from a wire standpoint, for the remarkably clear reports that went out through the air to the waiting radio-football fans.

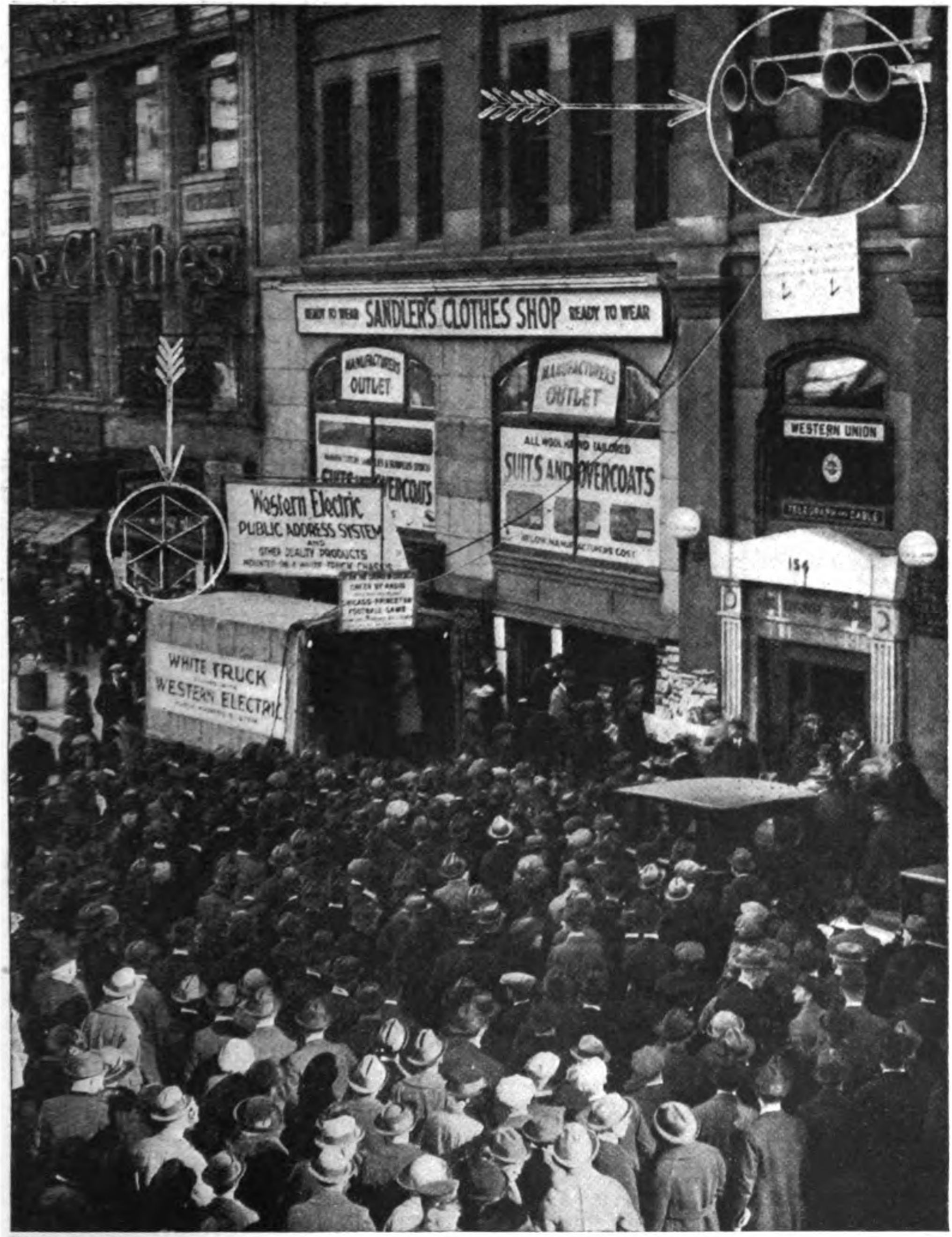
At the field itself, the occupants of Box 24 appeared to the casual observer pretty much like any other upper tier box party. Such an observer might have seen a man talking into what appeared to be an ordinary desk telephone; if he looked closely he might have observed another man, with receivers clamped over his ears, occasionally adjusting switches on a cabinet just above his knees or changing the position of a little square black box near the edge of the concrete rail. But if the observer happened to be a radio fan, he knew that the telephone and the little black box were the microphones, the instruments through which the account and noise of the game started on its way to the ears of listening thousands.

To illustrate the handling of the switches on the amplifying cabinet, let us see what happened during an exciting moment that occurred in one of the games—a drive toward the Dartmouth goal line by the Cornell team. The switch was thrown to one microphone and the announcer, W. S. Flitcraft, an experienced sports editor, was heard reporting:

"Fourth down; there is one yard to go. The ball is on the eight yard line."

Then the switch for the microphone at the south side was thrown and the cheering Cornell crowds were heard crying, "Touchdown! Touchdown!" Again, the switch was adjusted for the north side cheering section and with the change came the sharp cries of the Dartmouth crowds on the defensive, "Hold them! Hold them!"

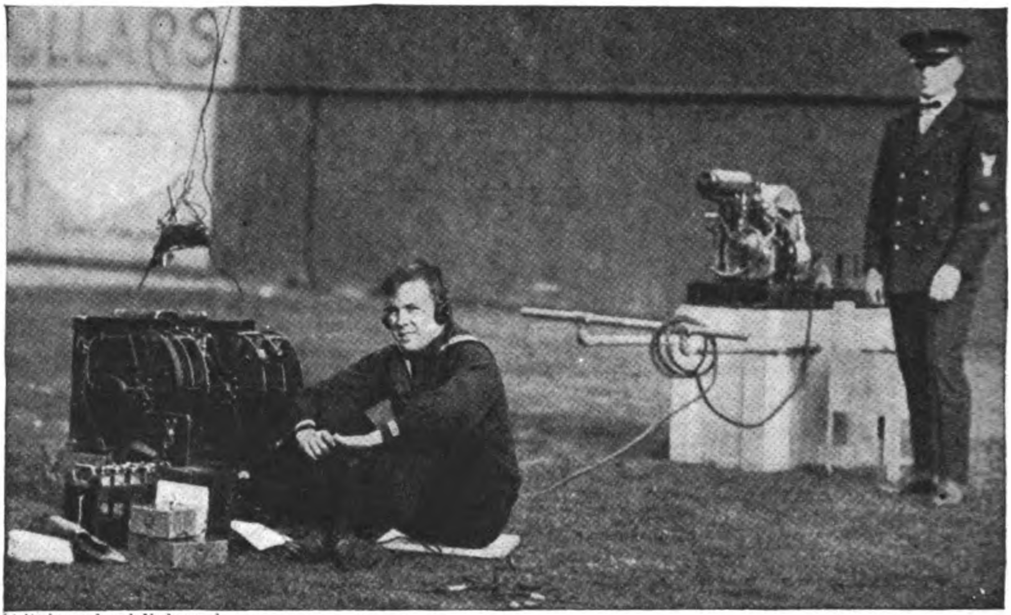
The writer sat in Box 24 at one of


READY TO WEAR SANDLER'S CLOTHES SHOP READY TO WEAR
MANUFACTURERS OUTLET
SUITS AND OVERCOATS
Western Electric PUBLIC ADDRESS SYSTEM AND OTHER QUALITY PRODUCTS
WHITE TRUCK
WESTERN ELECTRIC
WESTERN UNION
TELEGRAPH AND CABLE
154

Western Electric

A CITY STREET BECOMES A FOOTBALL GRANDSTAND

By the use of four loudspeakers (shown in the upper circle) the story of the Chicago-Princeton football game was made clearly audible above the noise of traffic to the great throngs that gathered before "The Tribune" Building in New York. The loudspeakers were furnished with energy picked up by a loop antenna (indicated in the lower circle) and a receiving set mounted on the truck, which is shown drawn up alongside the curb. The fact that the voice of the reporter on a football field in Chicago could be heard a thousand miles away in New York augurs a new era in the reporting of athletic contests.



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GOBS BROADCAST THEIR OWN GAMES

When the championship game between the teams of the U.S.S. Maryland and the U.S.S. Delaware was played in New York the sailors themselves set up this field radio sending station, so that their less fortunate mates aboard the ships could hear the story of the game, play by play.

the games and listened in through a pair of head phones during most of the play. At times he forgot the scene in front of him and could almost feel himself miles away, waiting in eager anticipation for the next word from the announcer, the next wild cheer that meant a long run or a cleverly executed forward pass.

The broadcasting of the Chicago-Princeton football game, played at Stagg Field in Chicago and broadcast from the station WEAF in New York, was of special interest because this was the first time that a voice reporting a sporting event had been carried over a long distance telephone wire and broadcast from a station many miles away. In this instance the *Newark Sunday Call* initiated the broadcasting of the game, the American Telephone & Telegraph Company supplied the broadcasting station and the Western Electric Company furnished the special amplifying apparatus which was placed at the athletic field. This special apparatus—amplifier, batteries, microphones—was of course practically the same as that used at the Polo Grounds in New York. However, the apparatus was placed in a booth in the press stand, the door of which was kept closed when the announcer recounted the plays.

But the details of the wire transmission over the telephone lines from Chicago to New York was the most interesting feature in the story of the broadcasting of this game.

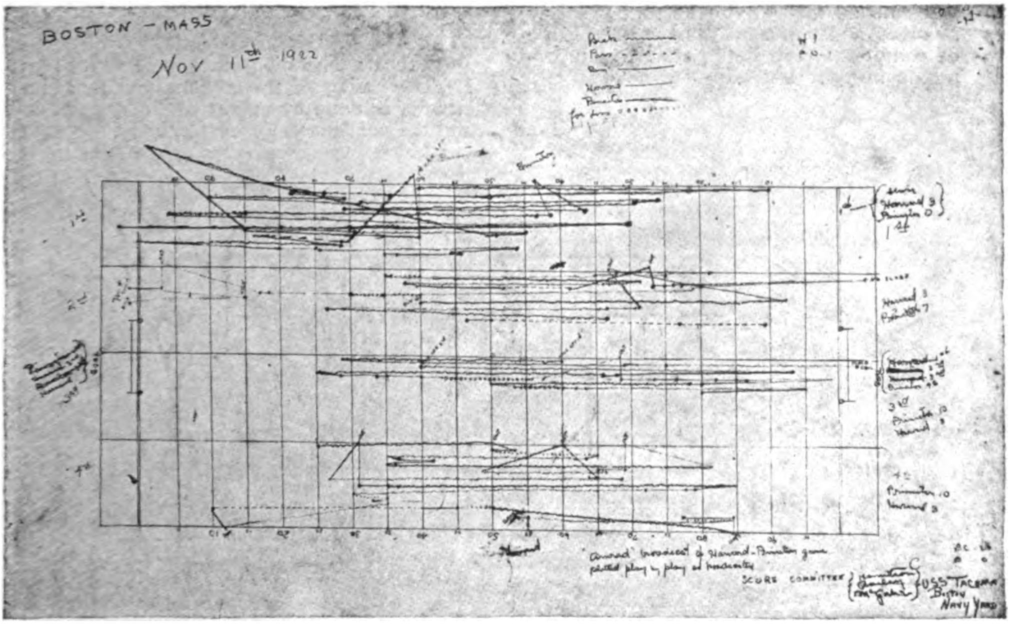
Stagg Field was connected up with Morrell Park, a Chicago suburb, by a special telephone line, thence by one of the regular lines to Beaver Dam, thence to Pittsburgh and then New York. At Morrell Park a one way telephone repeater was specially installed, at the other points the regular line repeaters were used.

One object that the radio experts are trying to attain is to bring to the listener the sounds of a voice—or any sounds—in natural, lifelike form. The ordinary telephone does not do this; it is not necessary that it should. But in broadcasting this a vital feature; it is of course vital in music, and a running account of a game is made more enjoyable if it comes in lifelike tones.

The speaking voice consists of a range of pitches over a wide interval of frequencies, roughly of from 100 to 5000 cycles a second; it is also composed of complex sounds. To bring, then, the voice to the listener in lifelike form hundreds of miles over a wire, it was necessary to have a circuit which would transmit with equal facility all the natural frequencies of the human voice.

In the transmission of the game from Chicago to New York the natural distortion of the regular telephone circuit was eliminated by the use of an electric network known as an "equalizer," which is a special type of electric wave filter, the invention of Dr. G. A. Campbell. The equalizer was placed at the first telephone repeater in Morrell Park. By this means all frequencies in the voice transmitted came over in natural strength and clearness, and an interesting experiment in the use of long distance wires to a far-away broadcasting station was successfully accomplished.

But beyond all the mechanics that make possible the bringing of events such as these fall sport classics to scattered millions, there is the element of human interest, exemplified best perhaps by just some little thing that brings to the comprehension in a sudden flash how much, in its developing future, radio can mean to mankind. This element of human interest showed itself in a letter received at Station WJZ from a town in the northern part of Connecticut. Four blind men had eagerly listened each Saturday to the games played at the Polo Grounds. The clear, running account given by the announcer must have been a revelation to these men who were blind, for they "saw" the game much better than if they actually had been there!



Amrad

A FOOTBALL GAME RECORDED BY RADIO

The fact that the sailors aboard the U.S.S. Tacoma were unable to attend the Harvard-Princeton game did not prevent them from following each play. This chart was plotted, during the progress of the game, on information broadcast from WGI.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our *subscription list.* A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.

QUESTION: I have an Atwater-Kent variocoupler, a pair of Murdock 2,000 ohm phones, a potentiometer, an audion detector unit, a Tuska socket, and a Radiotron UV-200 tube. Please give me a hook-up for these instruments.

T. J. H.

ANSWER: The diagram appears in Figure 1. The tuning of the antenna and secondary circuits is done by means of the tapped coil and the condenser VC respectively.

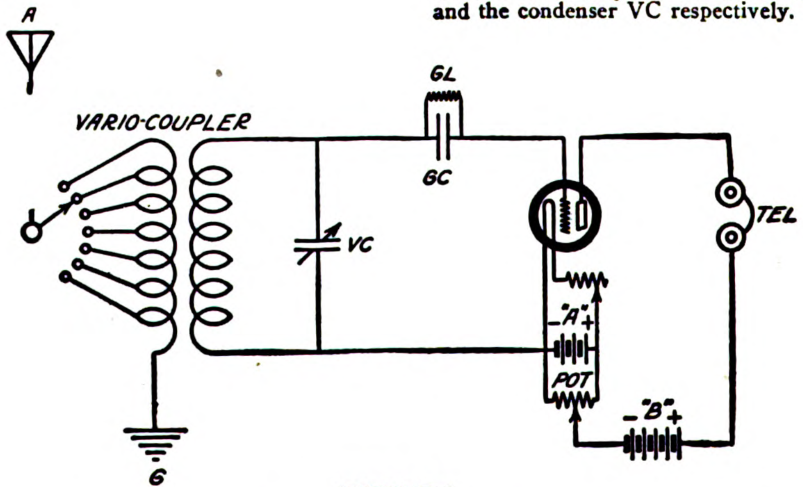


FIGURE 1

A vacuum tube circuit that employs a variocoupler and variable condenser for tuning. A potentiometer is used for adjusting the plate potential of the soft tube.

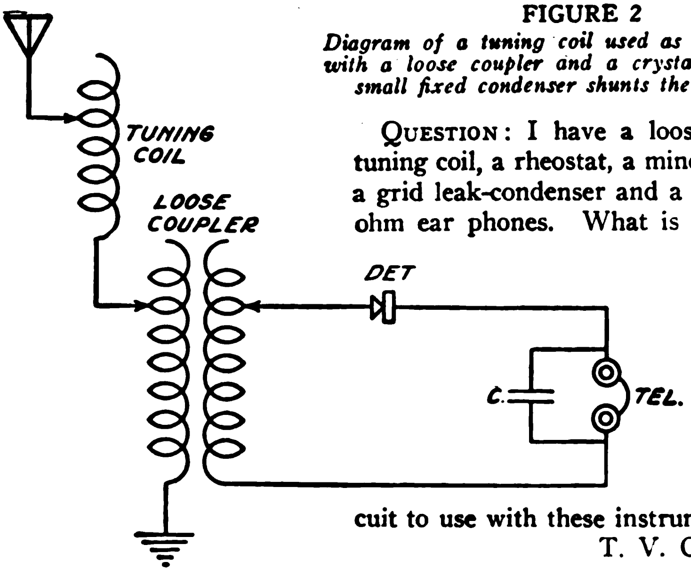


FIGURE 2

Diagram of a tuning coil used as a loading coil with a loose coupler and a crystal detector. A small fixed condenser shunts the telephones.

Question: I have a loose coupler, a tuning coil, a rheostat, a mineral detector, a grid leak-condenser and a pair of 2200 ohm ear phones. What is the best circuit to use with these instruments?

T. V. Galbraith

Answer: The circuit is shown in Figure 2. The tuning coil is used as a loading coil. The rheostat and the grid leak-condenser are not needed in this set.

Question: As I had no place to put up an outdoor aerial, I stretched a hundred feet of wire back and forth inside our attic. I have had good results with it. Is there the same danger from lightning as if this wire were outside? Do I need a lightning switch or outside ground with this type of an antenna, or is it unnecessary?

Aubrey H. Russell

Answer: Your indoor antenna will be no more of a hazard than the lighting circuits in your home or the buzzer wiring that rings your front doorbell. You do not need a lightning switch.

* * *

Question: Will you kindly give me a circuit for using a variometer, a .001 mfd. variable condenser, a .0005 mfd. variable condenser, with an audion detector?

A. J. Berger

Answer: The diagram shown in Figure 3 will be of use to you. You will need a 2 megohm grid leak, a rheostat, and "A" and "B" batteries to complete this set.

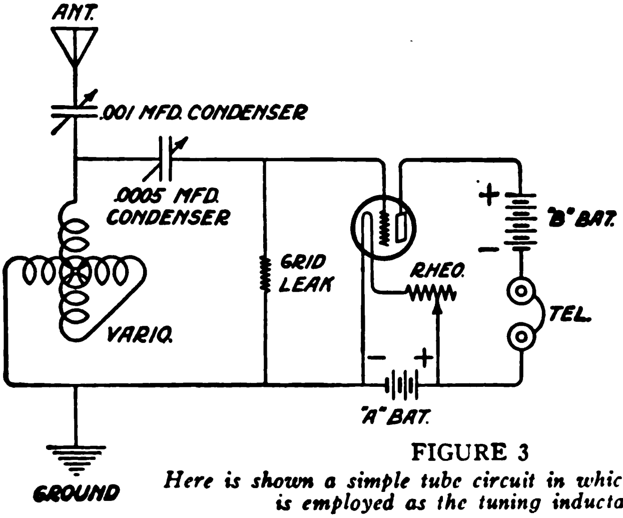


FIGURE 3

Here is shown a simple tube circuit in which a variometer is employed as the tuning inductance.

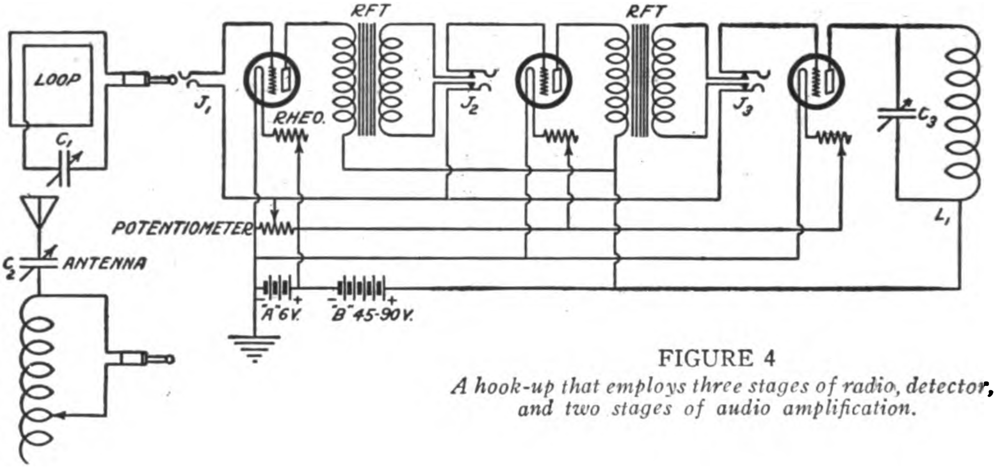


FIGURE 4

A hook-up that employs three stages of radio, detector, and two stages of audio amplification.

QUESTION: I intend to install a receiving set in a building next to a church and would like to use the auditorium of the church for giving radio concerts. Is it feasible to place the magnavox in the church, about thirty feet from the set, and still amplify the sounds enough to be heard by an audience in the auditorium? If this is possible it will easily solve my difficulties.

R. E. MIDDLETON

ANSWER: This will be both feasible and practical. Run two wires over from the building in which the set is installed and connect them to the two proper binding posts of the magnavox. The other ends of these two wires should be connected in the place where the telephones are ordinarily attached to the receiver. Then you may use a separate 6-volt battery for the two battery binding posts of the magnavox in the church. You must, however, tune the set with a pair of head telephones in the other building; when you have the set tuned, switch on the two wires leading to the magnavox.

* * *

QUESTION: Will I be able to hear concerts with a crystal receiving set and a loop antenna? If so, please let me know how a loop can be made.

H. STUBBINGTON

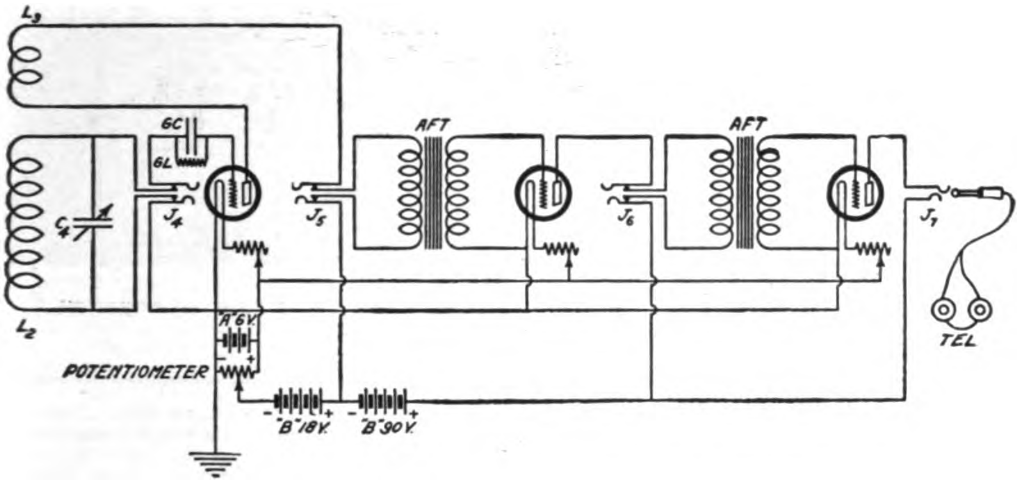
ANSWER: You will not get any results with a loop antenna attached to a crystal receiving set, as the loop antenna delivers a very minute quantity of electrical energy and this is insufficient for operation of a crystal detector. A loop must be used with vacuum tube amplifiers for efficient results.

QUESTION: I would like to get a good hook-up for making a set consisting of three stages of radio frequency amplification, vacuum tube detector, and two stages of audio frequency amplification, using a honeycomb tuner and arranged with jacks so that any stage of radio and any stage of audio amplification may be cut in or out by plugging into the correct jack. I wish to use two potentiometers, one for the radio frequency circuit and the other for the plate circuit of the detector tube; also separate "A" and "B" batteries for the radio and audio frequency amplifiers. I should like to use either an outdoor antenna or a loop with this set. Will you show me how?

J. W. CLARK

ANSWER: Refer to the hook-up shown in Figure 4. Here you will find a diagram that will give you the results you wish to obtain. The materials necessary are the following:

5 hard amplifying vacuum tubes
1 soft detector tube
6 vacuum tube sockets
4 variable condensers, .001 mfd.
1 tapped coil
2 potentiometers, 200 ohms
2 radio frequency transformers
2 audio frequency transformers
1 grid condenser, .0005 mfd.
1 grid leak, 2 megohms
6 rheostats
3 telephone plugs
5 double circuit jacks
2 single circuit jacks
3 honeycomb coils and mounting for same
1 loop antenna
"A" and "B" batteries
Binding posts



Question: Will you please send me a hook-up for a tapped coil, a vacuum tube detector, two variable condensers (21 and 43 plate), a fixed condenser, and a pair of 2000 ohm receivers? Is my aerial suitable for this set? It consists of two wires 100 feet long (each wire 50 feet high at one end, and 45 feet at the other) spaced 3 feet apart and made from number 14 bare copper wire. Would it make much difference if I have my ground switch inside the building during the winter?

Otto Stoltz

Answer: A diagram of a suitable circuit is shown in Figure 5. You will need a grid leak and condenser, shown in the diagram as GL and GC. Your antenna is suitable. The Fire Underwriters require the installation of the lightning switch out of doors; they make no distinction between the summer and winter seasons.

* * *

Question: How do you adjust the "pencil mark" type grid leaks?

E. L.

Answer: This type of grid leak may be adjusted in the following manner; to increase the resistance of the grid leak, rub off some of the pencil lines with an eraser; to decrease the resistance, add more lines with the working end of a pencil, or make the lines thicker. This should be done with the set in operation, with the telephones on the ears. Keep adding or withdrawing resistance until the signals are heard loudest, and then leave the grid leak alone.

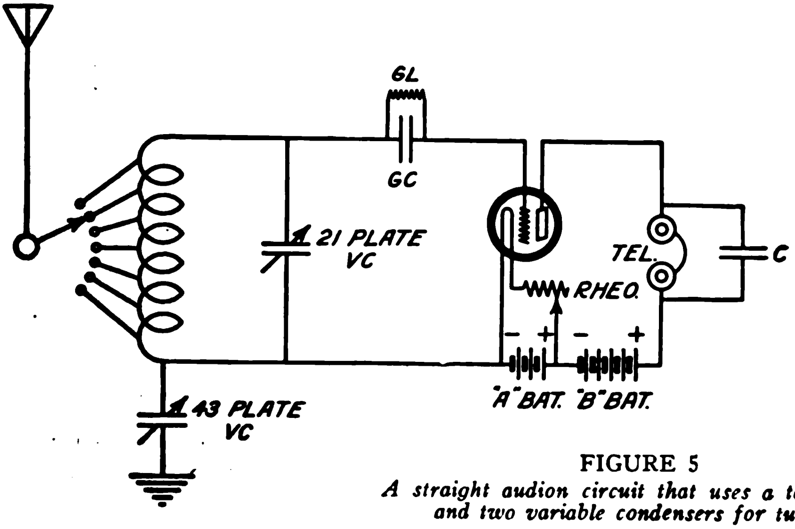


FIGURE 5

A straight audion circuit that uses a tapped coil and two variable condensers for tuning.

BROADCASTS

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

"Reading, 'Riting, 'Rithmetic"—and Radio

The young radio fan who lives in the vicinity of East Ninth street, in New York, does not have to play hookey when he builds his receiving set; he goes to Public School No. 64 instead. The construction of crystal sets is now a part of the school course; each pupil may own the set he builds upon payment of the actual cost of the raw material that he uses.

* * *

Fifty Radiograms an Hour

One of the radio operators on the liner *Majestic* recently sent out, on a four-hour watch, 200 complete messages, ranging from 8 to 65 words each. This is at the rate of one message in a little more than a minute, signatures, O.K.'s and "go-aheads" included.

* * *

Listening to the Sound of Their Money

Dressing up in one's Sunday-go-to-meeting clothes is no longer a requirement of the radio fan who attends church—not even when he attends the most fashionable houses of worship in the country. The latest recruit to the growing list of radio churches is the famous St. Thomas', in the very heart of Fifth avenue's exclusive residential district. The shut-in may now eavesdrop on New York's Four Hundred at prayer meeting by tuning in on WJZ. Every detail of the service may be heard—even to the dropping of the coins in the collection plate!

* * *

News Items in the Air

Sixty-eight newspapers in the United States are now maintaining broadcasting stations. Yet the uses of radio for collecting and disseminating news are only beginning to be developed.

* * *

Receiving Sets as Badges of Distinction

Foreign governments have not shown a consuming interest in the radio amateur; indeed, the American amateur cannot really appreciate his unusual advantages until he knows of the restrictions that are placed upon his fellows in other countries. The latest European country to exact tribute from the amateur is Czechoslovakia, which announces that each radio receiving set must be registered, and taxed—and not everyone will be permitted to own one.

* * *

Radio to Prevent Mine Disasters

The movements of 500 men engaged on construction work on a tunnel located thirty miles from headquarters in the Sierra Madre Mountains, of California, will be directed this winter by means of a radio station in the office of the resident engineer. The installation of a broadcasting station underground augurs the development of radio for controlling the activities of miners and other workmen in shafts, drifts and stopes elsewhere.

* * *

A Radio Clock

The rapid development of radio is proving of assistance to scientists in other fields. A German inventor, Heinrich Scheiferstein, through a study of the manner in which the oscillating currents in radio transmit energy to each other, has developed by the use of an oscillating motor, what he claims to be a noiseless timepiece.

* * *

A Unique Radio Switchboard

The fuel ship *Kamoi* of the Japanese Navy is said to have the most elaborate radio equipment of any vessel afloat. Among its odd features is a radio telephone exchange by means of which the ship's operator can transfer the control of the radio apparatus to any one of several stations. The exchange board resembles a telephone switchboard; a red light shows that the receiver has been taken from a phone hook, and the operator, by throwing a switch, puts the officer in control of both transmitter and receiver.

* * *

Paging Train Passengers by Radio

The first recorded instance of a commercial radiogram reaching a passenger on a morning train recently occurred on the Lackawanna Railroad, when a message received by telegraph at a station en route after the train had passed was relayed from the railroad broadcast station. Radiophones for two-way communication will soon be considered a regular part of passenger-train equipment.

* * *

An Automatic Fire Alarm—by Radio

A widely-known radio engineer, William Dubilier, has devised an apparatus by means of which fire signals may be broadcast by the operation of an automatic switch when water is set in motion by the opening of any valve in the pipes of the sprinkler system that is installed in buildings. A central listening station administered by the Fire Department may thus be enabled to hear the characteristic calls for each building and so locate the danger. The use of this system might conceivably mean substantial savings in fire loss.

* * *

Electioneering by Radio

During the gubernatorial campaigns just passed many of the candidates resorted to broadcasting—by which means they were enabled to come within the hearing of thousands, where formerly their audiences numbered but hundreds. The widespread interest in radio has established so many receiving sets in American homes that the spellbinder who has access to a powerful broadcasting station can extend the sphere of his influence immeasurably. Indeed, one may well conjecture to what uses a government-owned station might be put by shrewd politicians.

* * *

Radio Puts a Theater Orchestra in the Receiver's Hands

From Iowa comes news of a theater that has dispensed with its orchestra and installed an elaborate receiving set instead. The broadcasting stations of Chicago, Pittsburgh and Denver provide the programs, which are presumably known in advance, so that the musical director may tune in on the selections which best serve the exigencies of the moments on the stage.

* * *

Old Dr. Radio May Cure International Ills

Some idea of the effect which radio is destined to have in welding together the fragments of a broken world may be derived from the recent announcement of a "radio letter" service to London and Germany at the rate of only six cents a word. To what extent the nations will be brought into closer political, business and social contact by the extending use of radio is an interesting theme for speculation.

* * *

Radio for Smoking Out Genius

To discover and exploit local musical talent is the avowed purpose of the Society of Radio Artists and Audiences which has just been organized in Brooklyn. It aims to introduce to the public, through Station WHN, instrumentalists and singers who are capable and who will thus be saved the expense of a debut in recital in a concert hall under private management.

* * *

Fat Folks Made Lean—by Radio

A little girl in Massachusetts recently woke up one morning and saw her mother bending over and waving her arms about with a headphone strapped over her ears. The child was so startled that she called in the neighbors—who discovered that mother was merely going through setting-up exercises that were broadcast from Station WGI at seven o'clock every morning.

* * *

Radio Entertainers as Dictators

When sister studies shorthand at home evenings she need no longer impose upon the members of the family by coaxing them to dictate to her while she takes down practice notes. By merely adjusting the earphones of a receiving set she may get all the practice she wants by transcribing broadcast speeches. The idea originated in Pittsburgh.

* * *

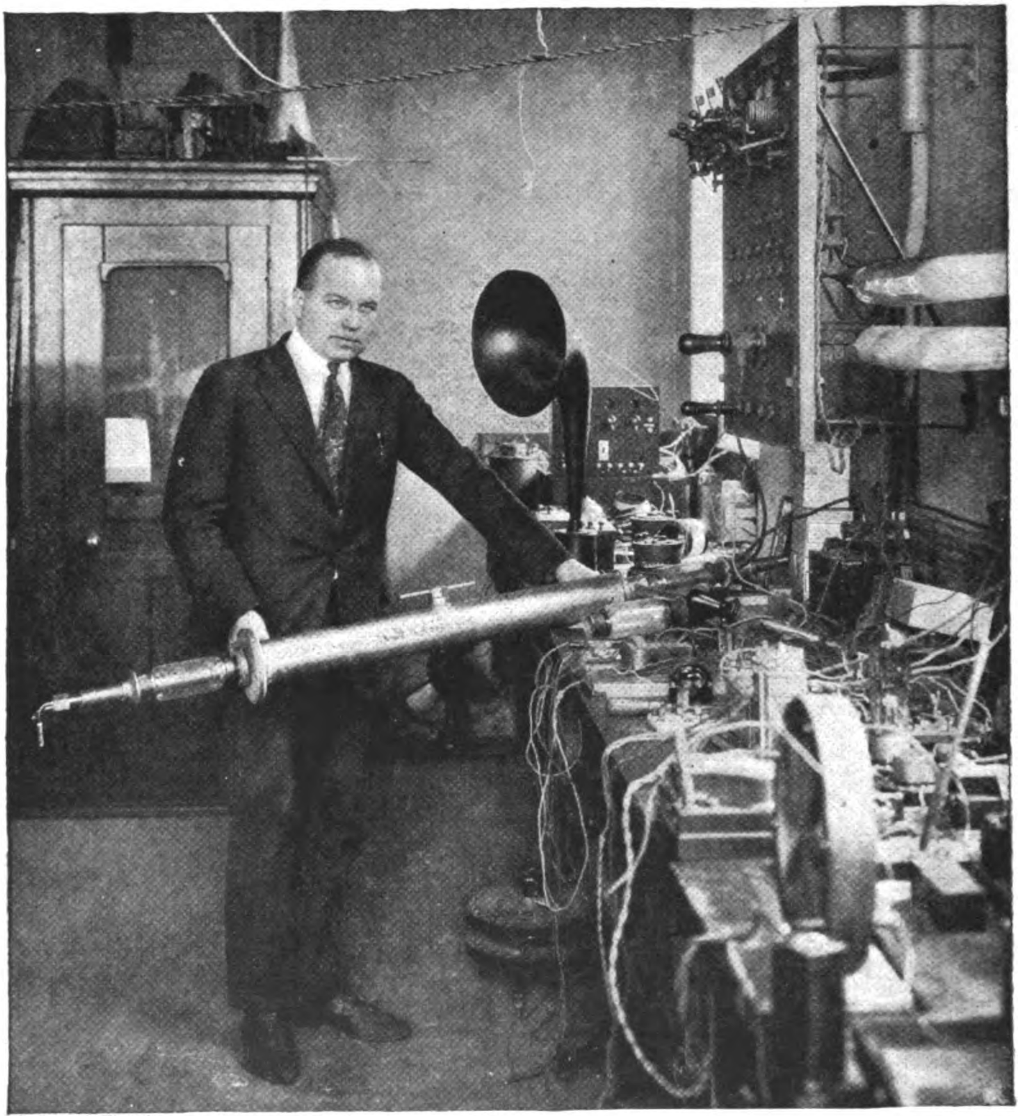
Broadcasting Stations in Every State

Every State in the Union now has one or more broadcasting stations. Wyoming was the last to be represented on the radio map. California leads the States with sixty-six broadcasting stations, Ohio follows with thirty-five and New York is third with thirty.

Sport-Commercial

THE NEW SPEED CHAMPION IN RADIO

Here is Joseph C. Smyth with the silver cup that proclaims him the fastest and most accurate receiver and transmitter of radio signals in this country. He won the "jamming," cipher code and straight press contests.



© General Electric

THE GRANDFATHER OF ALL VACUUM TUBES

No sooner does Popular Radio *introduce its readers to the 100-kilowatt audion built by Dr. W. G. Housekeeper as "the most powerful vacuum tube in the world" when along comes another announcement of a tube that is just ten times as powerful! This latest giant was developed by J. H. Payne, Jr., who made use of the discoveries made by Dr. Irving Langmuir and Dr. A. W. Hull. The father of this new prodigy is shown above, holding his child before the camera man. The power output of this tube is 1,000 kilowatts—sufficient to light forty thousand 25-watt electric incandescent lamps, or enough to light 1,500 average homes. An unusual feature of the tube is its lack of a grid; it is caused to oscillate by means of a system whereby the filament is heated by an alternating current of 10,000 cycles, the magnetic field of which serves to "cut off" the plate current 20,000 times a second and thus sustain oscillations in a circuit tuned to that frequency. Some idea of the significance of this invention may be obtained from the fact that this tube, with all its auxiliary apparatus, occupies a space barely six cubic feet—yet it is five times as powerful as the largest high-frequency alternators now in use. The time is coming when the large power plants now used in transatlantic communication work will be scrapped, and in their place will be a small compact station equipped with one or two of these vacuum tubes.*

What *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from* 50 *to* 300 *words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* Adventure in the Air Department, 9 *East* 40*th Street, New York City.*

I Pick Up a News Item of World-Interest

OCCASIONALLY the fan confuses the skeptic with a practical demonstration of the superiority of radio over the wire in the dissemination of news—as this adventure from the Middle West relates:

My most thrilling radio experience came shortly after the war, when the country was all excitement over the attempted transatlantic flights by Lieutenants Hawker and Greeley, who, it will be remembered, started to cross the ocean in a common airplane that was equipped only for land flights. They got off their course and were lost.

My grandmother was exceedingly anxious that these two aviators be found. Several times a day she would call up our neighbor, who was the editor of a local newspaper, to find out if the Associated Press had yet reported their rescue. Each time the editor would answer "No." In a few days the press gave them up as dead.

One evening as I sat at my radio set, playing with the 20,000-meter arc-stations, copying a little here and a little there (most of it being in code) a high and clear-pitched arc-station began with a "Q S T." It was the high-powered station at Nova Scotia. I had no trouble getting the signals, as the night was clear and no other station seemed to be working on that particular wavelength. I was not especially interested till I copied the names "Hawker and Greeley."

My heart took a jump. I copied the whole message without error; it was a report of the discovery of the two aviators, unharmed and safe. I ran downstairs and showed the message to my grandmother. She at once went to the telephone and called our editor friend and asked if there was any truth in it. No; the Associated Press had heard nothing of it. Of course, everyone doubted me and my radio message. I went to bed with my whole day ruined.

The next morning the editor called me up and reported that the two men had been found off the coast of Nova Scotia; the press got the news about 2 o'clock in the morning. Yet I had received the message at 10 o'clock the night before!

The local newspaper gave me a big write-up. It should have—for radio had beaten the Associated Press by four hours.

John L. Siegle (9DWZ)

I Dig Up a Voice from the Soil

ANY radio fan who has had experience with a pulsating current flowing in a wire, thus producing a magnetic field that induces a similar current in another wire within that field, will know the real explanation of the phenomenon described in the following letter from Sibley, Illinois:

When I had completed my first simple crystal set I spent my first day trying to tune in, but without success. Suddenly it occurred to me that my ground pipe was only a foot under the ground, so I went out and drove a stake about seven feet into the earth, then came back to my apparatus and tried again to pick up signals. This time I heard a low buzz. Soon someone began to talk. I was so excited that I did not listen in on the conversation but ran downstairs to tell my father. He came up to listen, but all was silent again.

An hour later I heard another conversation, and again I went to get my father. He was talking over the telephone; as I listened to him I realized that what I had heard on my set was merely the telephone conversation. This puzzled me. I started an investigation and found that I was picking up nothing but talk that came over the telephone wires. One end of my antenna was fastened to the telephone pole about a foot below the telephone wire, and the sound had jumped from one wire to the other.

HAROLD ACKERMANN

I Answer a Weird Call for Help

ANY fan would get a thrill out of the adventure of this amateur who lives in Bridgeport, Conn. If this were a play instead of a report of an actual occurrence it would be preceded by the rumble of stage thunder:

I must have been an odd person, I'll admit, for nothing could get me away from my radio outfit. Mac, my best friend, was another of the same crowd—always sticking to the job of twirling a few dials and knobs.

One dismal night I sat idly back in my chair listening to some strait-laced amateur voicing his opinion of the broadcasting conditions. He was amusing and I listened to his wrangling. I was forming my own opinions on that timely subject when some fool with a K.W. spark set opened up, keeping the key down for some time; he was apparently trying to send intelligent phrases but they were completely lost in a jumble. He seemed to be in a hurry, as he cut short some characters and ran others together. Suddenly I heard him distinctly form the call "JR"—*my* call, which was known and used only by Mac!

I strained my ears. The spark still kept on with its ponderous calling. He was calling "JR," of that I was sure. I did not become excited, however, until I heard distinctly and clearly three SOS's and then the signing—HC.

It was Mac, and he was SOS'ing me!

Again I listened. He formed the characters a little more clearly now.

"JR-JR, come over PDQ. Hurry or I will be out of luck for— — — SOS SOS," then the signature, "HC."

I rushed out into the rain, minus a hat and without rubbers or overshoes, to see what was the matter with Mac. He was a good sender and I could not account for the rotten way his fist had worked just a few minutes before. A dozen theories ran through my mind as I splashed from one ankle-deep puddle into another.

Out of breath and soaked to the marrow I finally reached Mac's shack. It was dark. I forced the warped door open and stumbled headlong over a chair and groped around until I found the electric switch.

Mac, wearing only his pajamas and soaked, was standing in that cold shack working the key for all he was worth. When I looked at him, I noticed that his eyes were tightly closed.

I remembered then that Mac was a somnambulist. While dreaming he had walked through a drenching rain to that cold shack just to carry out what was running through his mind. There would be another trip for poor Mac to make before he could get back to the warm house, and I dreaded the necessity of having to awake him, and explain matters. I never saw such a surprised person as Mac, when, with a good deal of strong-arm work, I finally got him quieted down. I stayed with him for the rest of the night, pouring hot lemonade down his throat and keeping him covered.

The next morning when I went home I found that I had left the lightning switch without throwing it, but the lightning had decided to keep away from my antenna. I had also left three tubes on, but luck had been with me—the tubes were still good, except for the fact that the battery was run down.

ELMER J. HUBER, JR.

Radio Is Opening a New World

TO THE EDITOR OF POPULAR RADIO:

"We are convinced that broadcasting has strong cultural value and that it is an effective means for developing an appreciation of good music by large numbers of people who might otherwise not realize what opportunities for refreshment and satisfaction music offers to them.

"We know from our experience in Rochester that this broadcasting service is a special boon to invalids who, though confined to bed by sickness, are enabled to hear the music of our concerts by means of receivers easily accessible to their beds.

"Broadcasting, properly conducted and supervised, must wield an undoubted influence for wider and richer culture."

RUSH RHEES, D.D.

President, University of Rochester

WORKRITE

LOUD SPEAKERS OF QUALITY

These Concertolas are very popular with "WorkRite" fans, and when you read about them and compare them with other Loud Speakers on the market you will easily see why.

Except for the phone units, THERE IS NOT THE SLIGHTEST METAL, in either the WorkRite Sr. or Jr. The sound chambers are made from our specially developed material, which reproduces voice or music in a clear, loud tone without the slightest distortion. Why listen to music through a "tin-panny" metal horn that loses all the beautiful tones of the artists, when you can get a WorkRite Concertola that will give you perfect reproduction of concerts?

The finish on these instruments is exceptional. The WorkRite Concertola Sr. is built from numerous plies of the finest mahogany, oil rubbed and finished exactly like your piano. It is 10" square by 15" high. Place it on your library table and run wires to your set in any other part of the house.

CONCERTOLA SR.

READ WHAT THIS CONCERTOLA FAN SAYS

"I tried out thoroughly last evening your WorkRite Concertola and am very much pleased with the results. The music and voice from distant stations come in clear and distinct and loud enough to be heard all over the house. THE SQUEALS, HOWLS AND OTHER RACKET I'VE HEARD THROUGH POWER SPEAKERS AND METAL HORNS ARE ENTIRELY ABSENT. The music comes in with a clear, mellow tone and without distortion. Here are the stations I've heard: WJZ, WEM, WGY, WHB, KLZ, WBAP, WWJ, KYW, WHAS, and WOC. The Concertola is the finest loud speaker I have yet heard."

L. A. Crackel, 508 N. 5th St., Champaign, Ill.

These Concertolas are designed for use with vacuum tube sets having two-stage amplification. Get one for your set now, so you will have it to enjoy during these winter evenings.

CONCERTOLA JR.

WorkRite Concertola Jr. with Cord and Phone Unit, $12.00
WorkRite Concertola Sr. with Cord and Phone Unit, $24.00

OTHER WORKRITE RADIO PRODUCTS

- **WorkRite Super Variometer**
- **WorkRite Super 180° Variocoupler**
- **WorkRite E-Z-Tune Dial**
- **WorkRite Super Vernier Rheostat**
- **WorkRite Concert Headphone**
- **WorkRite Switch Sets and Parts**
- **WorkRite Type "A" Hydrometer**

SEND FOR OUR FREE CATALOGUE

THE WORKRITE MFG. CO.

5544 EUCLID AVENUE CLEVELAND, OHIO
(Branch Office: 2204 MICHIGAN AVE., CHICAGO)

CONCERTOLAS

"We Are Now Signing Off—Good Night!"

Now Attach

THE

HOMCHARGER

To your AC lamp socket, snap the clips on your storage battery and "turn in."

While you sleep, the RADIO HOMCHARGER DE LUXE is silently charging your battery—the charging rate being governed automatically. In the morning it is fully charged; ready for another evening's entertainment, and the cost has been less than a nickel for current consumed.

No muss, trouble, dirt—no moving of battery—loss of time. You can't connect it up wrong—it can't overcharge nor harm your battery in any way. Its beautiful mahogany and gold finish will harmonize with any living-room.

Furnished complete with Ammeter, Attachment Cord and Plug, Charging Cahle and Battery Clips, by all good dealers handling radio and electric equipment, for $18.50.

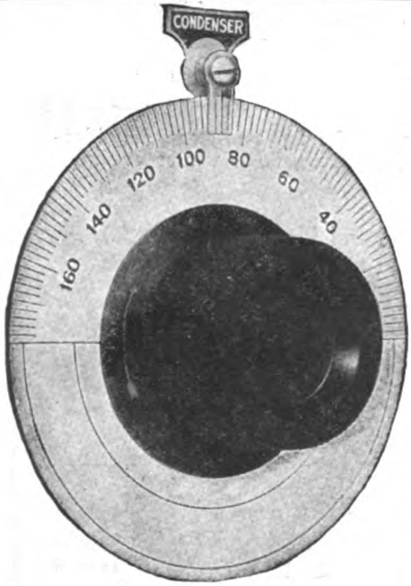
Ask your dealer for Bulletin No. 637, illustrating the new HOMCHARGER in actual colors, or write direct.

CAUTION When buying a Rectifier insist upon the following:

1—SELF-POLARIZING feature, otherwise your battery may be ruined through reverse charging.
2—AT LEAST FIVE AMPERE CHARGING RATE, otherwise it will require several days to fully charge your battery.
3—UNDERWRITERS' APPROVAL, otherwise in case of fire your insurance may be void.

THE HOMCHARGER is the only Rectifier at any price which combines the above, three NECESSARY HOMCHARGING features.

The Automatic Electric Devices Company
132 West Third Street, Cincinnati, Ohio



SOMERVILLE

STANDS FOR

DISTINCTIVE APPEARANCE AND OPERATING CONVENIENCE

THREE EXCLUSIVE ADVANTAGES

FIRST	Silver lacquered brass dial contrasts with Black Panel. The knob fits the fingers without fatigue.
SECOND	Lower half of scale may be calibrated in meters or station call letters with pencil.
THIRD	The tail of dial tag makes contact with back of dial and connects with ground, removing hand capacity.

A CHRISTMAS GIFT

To introduce our DIALS in new sections, where there are no Somerville Dealers, we will give one FREE with either an **AMRAD $5.50 Basket Ball Variometer,** or a **$6.25 Basket Ball Coupler.** This advertisement must accompany order. Offer withdrawn January 15th.

Somerville Terminal Tags prevent mistakes in connecting battery leads. May be put on any set—old or new—and cost but 5c. Sample set, 40c.

4-in. Dia. Dials	**$1.50**
3¼-in. Dia. Dials	**1.00**
1¾-in. Dia. Knob	**.60**

Specify ¼-in. or $\frac{3}{16}$-in. Shaft Hole.

SEND TWO-CENT STAMP FOR CATALOGUE

SOMERVILLE RADIO LABORATORY
43 Cornhill *Established 1917* **Boston, Mass.**

The proof is Performance

Bel-Canto

The Superlative Loud Speaker

THE Bel-Canto Loud Speaker ***has made good.***

There is only one reason for the radio public's enthusiastic acceptance of this remarkable instrument and only one proof of the Bel-Canto's superiority over other loud speakers—*Performance!*

Hear the Bel-Canto. Hear the loud, clear, undistorted reproduction of this masterful invention. You will agree with the hearty endorsement of that world-famous pianist, Paderewski. He heard the Bel-Canto and wrote us about it: "The clarity and volume of tone and particularly the absence of distortion make the Bel-Canto a remarkable device. You are indeed to be congratulated."

The Bel-Canto is not simply "another" loud speaker. It is a revolutionary instrument in the world of radio music. The Bel-Canto is built on the most perfect acoustic principle known to science—*the human vocal organs.* From the diaphragm of its supersensitive reproducing phone to the hollow, air-tight resounding chamber, this principle is faithfully carried out. The result is an instrument whose perfect reproduction of music and the voice is unequaled by any other loud speaker that we know of—no matter what the price.

The Bel-Canto is handsome in appearance—an addition to the finest home or apartment. The instrument comes complete—ready to plug right into your set. No head phones are necessary. The Bel-Canto includes special reproducing phone, hard rubber plug, and ample cord. The price complete is $30.

Go to your dealer's today and hear this Loud Speaker of loud speakers. You have a real surprise awaiting you.

If your dealer has not yet stocked the Bel-Canto we will send you postpaid the complete Loud Speaker on receipt of price, $30. Or C.O.D. if you prefer.

Guarantee: Each Bel-Canto is thoroughly tested before it leaves our factory. If it doesn't give entire satisfaction we will replace it with a new one, provided the plate on the bottom has not been removed.

Special Offer to Dealers

Send us your name and address and we will ship you C.O.D. one Bel-Canto, giving you the maximum discount from the list price. We want you to introduce the Bel-Canto to *your* trade. One introduction will bring enough enthusiasm on the part of your customers to warrant a reorder. That has been our experience with other dealers. Why don't *you* try it and see? We'll give you your money back if the Bel-Canto doesn't beat out your expectations.

Bel-Canto Corporation
417 East 34th Street : : New York

Kellogg Radio Equipment for Better Results

Easy to Mount—Simple to Operate

Variometer

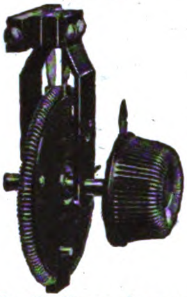
The stator and rotor are of Kellogg Bakelite, with properly proportioned windings of well insulated copper wire.

Two terminals are provided for the rotor and three for the stator, permitting the variometer to be used in all the known variometer circuits.

Kellogg variometers have no sliding contacts; nothing to wear or "short." A spring takes up all play and allows the rotor to turn with a smooth, even motion.

No. 501..........Each $8.00

Rheostat

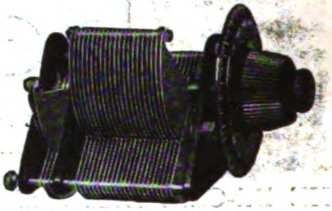


The Kellogg rheostat is of simple design, having but one moving part.

It is so arranged that a maximum contact surface is provided, making perfect contact. To assure perfect current to the most critical tube, the rheostat operates on the half turn of the resistance element.

No. 501............Each $1.50

Variable Condenser



The Kellogg variable condenser is of the decremeter type and is unusually well built throughout. A customer writes: "It is in a class by itself."

No. 601. 11 plate with 5 plate Vernier Knob and 4 in. Dial Each..................$6.75

No. 602. 11 plate without Vernier. Less Knob and Dial. Each..................$4.50

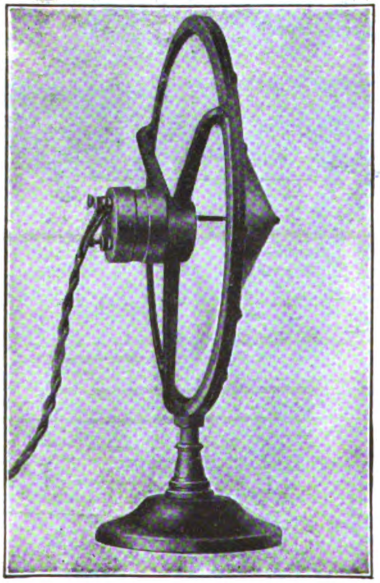
No. 603. 23 plate with 5 plate Vernier. Knob and 4 in. Dial. Each..................$7.75

No. 604. 23 plate without Vernier. Less Knob and Dial Each..................$5.50

No. 605. 43 plate with 5 plate Vernier. Knob and 4 in. Dial. Each..................$8.75

No. 606. 43 plate without Vernier. Less Knob and Dial. Each..................$6.50

KELLOGG SWITCHBOARD & SUPPLY COMPANY, CHICAGO



THE PATHÉ LOUD SPEAKER

Has No Superior

It reproduces exactly the sound sent out and has none of the "tinny" noise that must come from a metal horn. It operates with any two stage amplifying set. Insist on hearing a Pathé operate before you buy.

Price, $24

THE SOUND WAVE CORPORATION has been consolidated with THE PATHÉ FRERES PHONOGRAPH COMPANY, and the new company is known as

THE PATHÉ PHONOGRAPH AND RADIO CORPORATION
30 Grand Avenue, Brooklyn, New York
Makers of Quality Dials, Variometers, Variocouplers, and Loud Speakers

For the money the Ford is a very good car

You get a place to sit between four wheels that keep going. You don't expect quality-car looks, finish, comfort or smoothness of operation. You get about what you pay for.

It is not otherwise with radio apparatus. There are single circuit receiving sets that sell for less than the Paragon three-circuit receiver. All single circuit receivers will let you listen in, after a fashion, on radio programmes. But you will get mixed messages and general jamming between the numerous broadcasting stations all operating on one narrow wave band.

If you want to get real service, pleasure and satisfaction out of radio, buy a receiving set that is more than a make-shift. Ask some experienced radio amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its greatly superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Also Manufacturers of PARAGON

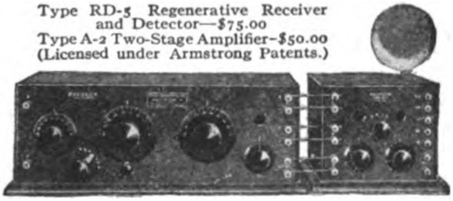
- Radio Telephone Transmitters
- V. T. Control Units
- Rheostats
- Potentiometers
- V. T. Sockets
- Detectors
- Amplifier Transformers
- Control Dials
- Amplifiers
- Receivers
- Switches
- Variometers

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

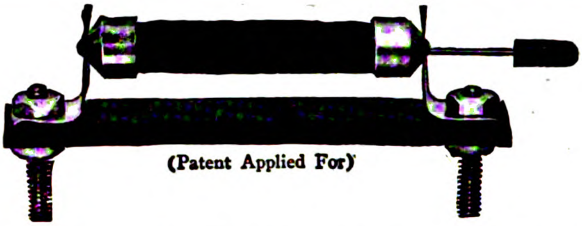
An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.



Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier-$50.00
(Licensed under Armstrong Patents.)



(Patent Applied For)

THE ONLY ONE IN AMERICA

With the usual type of "Grid Leak," which is of fixed value, it is necessary to try a number of them to determine the one best suited.

The Durham Variable High Resistance

(Adjustable Grid Leak)

is the only one of its kind now on the market, because it is *adjustable* over a wide range and will maintain its value permanently after initial setting—It is non-inductive and has negligible capacity.

Made in two sizes:
No. 100—1,000 to 100,000 ohm range
No. 101—100,000 to 5,000,000 ohm range

Price 75c. Base 40c.

DURHAM & COMPANY

1936 Market Street *Radio Engineers* **Philadelphia, Pa.**

Pruden Reliable Radio Specialties

FOR GOOD RESULTS!

THE name "Pruden" back of standard Radio Equipment is a guarantee of mechanical excellence, perfection of workmanship and scientific correctness of design.

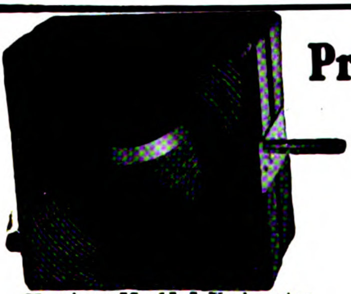
Now, more than ever, when the market is flooded with inferior goods, it pays to buy standard trade marked products.

You can pin your faith to "Pruden." Money-back unconditionally if you do not get complete satisfaction.

Just a few leaders of Pruden Reliable Products shown here that will give you better radio results at no greater cost.

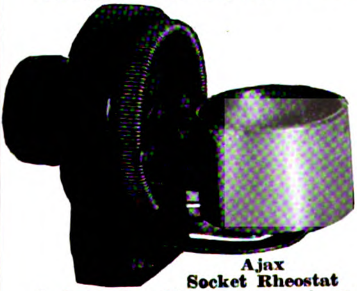
Everything sent F. O. B. Jersey City. Send money by registered mail, post office or express money order.

Dealers write today for our interesting proposition



Keystone Moulded Variometer

Made of a special composition—extremely light in weight and durable. Wave length ranges from 150 to 580 Meters. Terminals conveniently arranged to afford easy connections and avoid crossing terminal wires. Rotor and Stator windings guaranteed not to loosen.
Brush type contacts. List each **$5.00**



Ajax
Socket Rheostat

A device for which amateurs and professionals have long been waiting. Eliminates wiring between socket and rheostat. List each **$2.00**

FREDERICK H. PRUDEN Inc.
999-P Bergen Ave. Jersey City, N. J.

Satisfy Yourself

The Music Master

RADIO AMPLIFIER

True tone at last! Music Master Horn Conquers "Screech" and "Snarl" and "Howl" and makes listening a joy!

ASK any reliable Radio Dealer to demonstrate the Music Master on your set at home. The severest test leaves no doubt of perfection.

Fits any set, no extra batteries or current needed, makes headsets useless. Everybody can listen to any program. Speech or music—both are heard through the Music Master, each tone and emphasis is exact.

Fourteen inch aperture (Home Model) $30
Twenty-one inch (Concert, dancing, etc.) $35

Send us the dealer's name so that we can be sure that he is supplied with a Music Master to show you.

JOBBERS—DEALERS

Sample Horn shipped to responsible members of the Radio or Phonograph trade with *full privilege of return.*

Prices and full details on request.

"GERACO" LINE

Includes everything of tested merit in Radio apparatus and supplies.

Write for prices and literature.

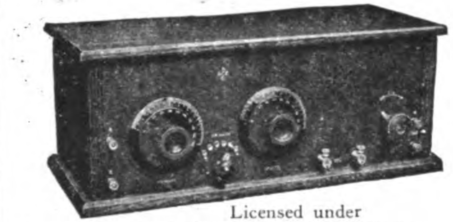
The Geraco Phonograph Attachment makes your Victor or Columbia an excellent loud speaker for Radio.

Interchangeable with sound box—$10.

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus
624-628 Market Street, Philadelphia

Chicago — Pittsburgh

GERACO
PROVEN RADIO PRODUCTS



Licensed under
Armstrong U. S. Patent
No. 1,113,149

WERE you one of the hundreds of satisfied Christmas purchasers of an ACE Radio Concert Receptor?

If not, you still have an opportunity to get immediate delivery if you place your order *now!*

Let us send you our booklet, " Radio in Your Home "

Address Dept. XM

THE PRECISION EQUIPMENT CO.
2437 Gilbert Avenue
Cincinnati, Ohio

RHAMSTINE*
RADIO FREQUENCY
TRANSFORMER

$4.50

Complete with mounting

A handsome, efficient unit, of the high Rhamstine* standard.

The bayonet mounting allows changes of transformer instantly for the other wave lengths, without disturbing base or wiring.

The type 1 R.F. Transformer, with its range of 200 to 500 meters, gives best results with the present broadcasting wave lengths.

We will gladly send descriptive folder.

Manufactured by
J. THOS. RHAMSTINE*
2152 E. Larned St. Detroit, Mich.
***Maker of Radio Products**

Compare These Prices

Why Pay More When You Can Get Rock Bottom Prices From Us

$ Save $ Save $ Save

Just glance over our list and send us your money order. Twenty-four hours after receiving your order, it is on its way to you.

List Price		Our Price
$5.00	Radiotrons UV-200	$4.25
6.50	Radiotrons UV-201	5.75
16.00	Baldwin Phones Type C	13.98
7.75	Baldwin Unit Loud Speakers	6.75
45.00	Magnavox	38.00
25.00	Western Electric Phones (same as used in Signal Corps)	11.00
8.00	Federal 2,200 ohm Phones	6.00
8.00	Brandes Superior Phones	7.00
1.00	Double Jacks	.60
.70	Single Jacks	.50
2.50	Bull-Dog Plugs	1.25
1.50	100 ft. stranded Aerial Wire	.50
.50	Aerial Insulators	.20
1.00	100 ft. stranded Aerial Wire	.40
75.00	Paragon RA-10	68.00
25.00	90 Ampere guaranteed storage Battery	16.00
8.00	Westinghouse W.D. 11 Tubes 1½ Volt operated on 1 Dry Cell. Can be used as Detector or Amplifier	6.50
1.50	Sockets for W.D. 11 Tubes	1.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.65
1.00	Vacuum Tube Socket	.50
18.50	Homchargers (New Style)	16.50
3.50	B Batteries Volt Meters o-50 V	2.75
4.50	Murdock Enclosed 43 plate Variable Condensers	4.00
4.00	Murdock Enclosed 23 plate Variable Condensers	3.75
3.25	Murdock Panel Mounting 23 plate Variable Condensers	3.00
4.00	Murdock Panel Mounting 43 plate Variable Condensers	3.60
3.75	23 plate Variable Condensers	2.25
4.75	43 plate Panel Mounting Variable Condensers	2.50
12.00	Western Electric VT-1	7.50
13.00	Western Electric VT-2	8.50
8.00	Atwater-Kent Variometers	7.25
8.00	Atwater-Kent Varicouplers	7.25
4.50	Thordarson Audio Transformers	3.75
1.00	Fixed Condenser	.50
1.50	Crystal Detectors	.75
8.00	3000 Meter Loose Couplers	4.75
4.00	Tuning Coils	2.00
	Contact Points (per doz.)	.15
	Switch Levers 1½ in. Radius	.25
	Honeycomb Coils, All Sizes, 20% Discount	

Space being limited we are obliged to omit many items.

Write for our quotations.

Cut Rate Radio Co.
DEPT. A
P. O. Box 472 Newark, N. J.

PERFECT ELECTRIC CONTROL

RESIST-O-METER

TRADE MARK

The Resist-O-Meter illustrated is Type A Filament. Price, $1.80

Your radio receiving set—has it a Resist-O-Meter?

It should have.

The Resist-O-Meter gives you a better outfit by far. You will notice the difference immediately. It is the *ideal* variable resistance.

You need these rugged instruments which provide for an extremely delicate *and continuous* variation in resistance to properly control the current flow from the "A" and "B" batteries of your radio set. Hook up a Resist-O-Meter. You will never go back to the old type.

The Scholes "Resist-O-Meter"—

—is micrometer controlled and *continuously* variable between the extreme ranges of its terminals.

—is non-microphonic.

Possesses the lowest resistance at full compression (practically zero).

—is made in models covering every requirement for radio use.

—is compact and convenient, and takes up very little space in standardized mounting.

The Scholes Radio & Manufacturing Corporation holds the sole license to manufacture this type of current control, under patents granted Mr. F. A. Rojas, Nos. 15478 and 1366945, other patents pending. It is sold only under the trade mark name "Resist-O-Meter." Ask your dealer to supply you.

Write to Mr. C. W. Preston

THE SCHOLES RADIO & MANUFACTURING CORP.

33-36 West 18th Street, New York City

We manufacture the products listed below:

Resist-O-Meters

Type A—Filament
" B—"B" Battery
" C—Potentiometer
" D—Variable Grid Leak

Test-Rite Condensers in following capacities:

Phone	.001	mfd.	
Grid	.00025	"	
Grid	.0005	"	
Grid Leak	.0005	"	1-meg.

V. T. Sockets
Engraved Binding Posts
Accessories

For Your Radio Xmas!

Two New

Popular Radio

Subscriptions

$2.50

Make it a radio Xmas! The most acceptable gift to every radio enthusiast is the gift that costs least and lasts longest—A Year's Subscription to POPULAR RADIO. You may have two yearly subscriptions for a little more than the cost of one. Include $.25 for Canadian postage and $.50 for foreign countries. The subscription rate goes up early in the New Year. Better act right away. *Use the double coupon.*

Coupon Good Until January 21, 1923.

POPULAR RADIO
9 East 40th Street, New York City
Please send POPULAR RADIO for one year to:

NAME......................................

ADDRESS..................................

CITY.......................STATE..........

And also to this other new subscriber. Here's my cash remittance—(or a check for two-fifty).

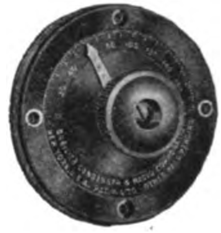
NAME......................................

ADDRESS..................................

CITY.......................STATE..........

To the left is the standard air variable condenser.

Below is the Dubilier Variadon as supplied from the factory, with graduated scale and knob.



The New Variadon—

No thicker than an ordinary dial

THE following are the more remarkable features of the new Dubilier Variadon, the first practical mica variable condenser:

1. It is no thicker than an ordinary dial. Yet it serves the purpose of an air-condenser with several dozen plates.

2. It can be mounted on any convenient part of a receiver case (front or rear of panel).

3. Its adjustment cannot be destroyed by ordinary shocks, falls or vibrations. Hence short-circuits are practically impossible.

4. It makes the vernier unnecessary.

5. It can be used as a grid-leak condenser, so that new tubes or different tubes can be adjusted to suit the receiving set.

Capacity .0004 or .0006 mfd. Retail price $2.50.

Capacity .001 mfd. Retail price $3.50.

Supplied complete with dial and knob.

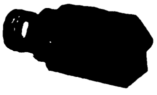
Other Famous Dubilier Products

Dubilier Micadons

Micadons are little mica condensers which reduce tube noises. Made in a wide range of capacities. Price 35 cents to $1.50 each, according to capacity.

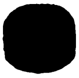
The Ducon

Screw the Ducon in any lamp socket and thus do away with the antenna. The broadcasting station comes in loud and clear. Price $1.50.



The Du-tec

A chemical rectifier of which every spot is sensitive. Eliminates tedious and frequent adjustment of "cat whisker." Does not oxidize with age. Price, mounted, 30 cents each.



DUBILIER Condenser & Radio Corp.
48-50 West 4th St. N.Y.

DISTRIBUTORS AND BRANCH OFFICES

SAN FRANCISCO, CAL., 709 Mission St.
ST. LOUIS, MO., Syndicate Trust Bldg.
WASHINGTON, D. C., Munsey Building
CHICAGO, ILL., 33 So. Clinton Street
ATLANTA, GA., Forsyth Building

Distributed in Canada by General Electric Company, Ltd., Toronto

CLICKERTY CLANK

Does your rheostat go—"Clickerty-clank! BANG!" whenever you make an adjustment? It would not if it were General Radio constructed. When your tube is approaching the critical point, it is necessary that the adjustment be fine and introduce no extraneous noises in your head phones.

When you construct your set, you would not mount a toaster on the panel. Then why mount a rheostat that runs hot? The radiation surface of the General Radio rheostat is sufficient to permit the rheostat to be mounted in small enclosed spaces without fear of heat damage.

The base is real bakelite—no substitutes used. The switch blade is rugged phosphor bronze and polished nickel plated. The knob is convenient and attractive.

Made in two styles, Type 214-A for back-of-panel mounting, and Type 214-B for front-of-panel mounting or portable use. Also made in two sizes, for receiving tube and for power tubes.

7 ohms, 1.5 amps. for receiving tubes

2 ohms, 2.5 amps. for receiving tubes

PRICE, any style $2.25

Similar in general dimensions and design to the rheostat is the 400-ohm potentiometer. This instrument is ideal for grid biasing.

PRICE, any style $3.00

Send for Free Radio Bulletin 911-U

GENERAL RADIO COMPANY

MASSACHUSETTS AVENUE AND WINDSOR STREET
CAMBRIDGE 39, MASSACHUSETTS

Do not confuse the products of the GENERAL RADIO CO. with those of other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific instruments for many years. It has no affiliation with any other company.

Standardize on General Radio Equipment Throughout

BRILLIANTONE RADIO PRODUCTS

Dept. C—874 Columbus Ave., New York

$1.00 Brings any one of these Combinations quickly to you

No. 1

100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lighting switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

No. 2

1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.

No. 4

1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.
1 Spool No. 24 cotton covered wire, 375 feet.
1 Hardwood Rotor.
All the above merchandise guaranteed or money refunded.

— — — — — — — — CUT HERE — — — — — — — —

Please Check Before Items Desired—Fill in Coupon and Mail

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐	B.R.P. Rheostats, fibre base (Tapered Type)...	$ .50
☐	B.R.P. Rheostats, porcelain base..............	.75
☐	B.R.P. Potentiometer (200) ohms)..............	1.00
☐	B.R.P. Moulded Sockets (unbreakable)..........	1.00
☐	B.R.P. Audio Frequency Transformers (11 to 1)	4.00
☐	B.R.P. Radio Frequency Transformers (150 to 500 M.)..............................	3.00
☐	B.R.P. Variometer (to 800 meters).............	3.00
☐	B.R.P. Variocouplers (Panel and Laboratory Type in one)............................	3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐	3 Plate, capacity .00005..........................	$1.50
☐	7 Plate, capacity .0001..........................	2.00
☐	11 Plate, capacity .0003..........................	2.50
☐	23 Plate, capacity .0005..........................	3.00
☐	43 Plate, capacity .001..........................	3.50

TYPE "B"—ALUMINUM ENDS

☐	3 Plate, capacity .00005..........................	$1.00
☐	7 Plate, capacity .0001..........................	1.25
☐	11 Plate, capacity .0003..........................	1.50
☐	23 Plate, capacity .0005..........................	1.75
☐	43 Plate, capacity .001..........................	2.25

STANDARD MERCHANDISE AT REDUCED PRICES

☐	$4.50 Thordarson Amp. Transformers (Audio)	$3.00
☐	$7.00 UV712 Audio Frequency Transformers (Radio Corp.)..............................	6.00
☐	$6.50 UV1714 Radio Frequency Transformers (Radio Corp.)..............................	5.50
☐	ZETA Radio Frequency Transformer...........	3.50
☐	Brandes "Superior" (2200 ohms)..............	6.75
☐	Murdock (3000 ohms)........................	5.00
☐	Federal (2200 ohms)........................	6.50
☐	Klosner Vernier Rheostat...................	1.00
☐	Bradleystat (Best Vernier).................	1.65
☐	Jacks, single, open or closed (Firth)........	.35
☐	Jacks, double, closed (Firth)...............	.50
☐	Plugs, bulldog grip (Firth).................	1.00
☐	.002 and .005 Mica-Bakélite Condensers.........	.25
☐	.0005 and .00025 Condensers with Var. Leak....	.25
☐	.0005 and .001 Fixed Mica-Bakelite Condensers	.20
☐	Two-Slider Tuning Coil (mounted)............	1.50

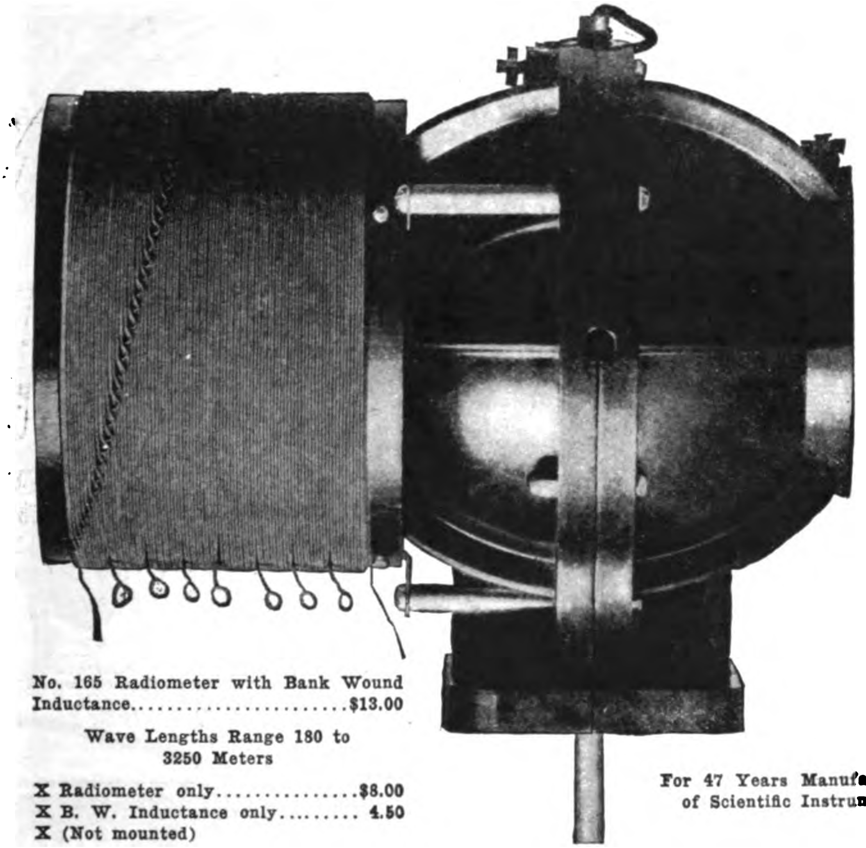
BRILLIANTONE RADIO PRODUCTS
Dept. C, 874 Columbus Avenue, New York

Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

Name ....

Address ....

City ....



No. 165 Radiometer with Bank Wound Inductance......................$13.00

Wave Lengths Range 180 to 3250 Meters

X Radiometer only..............$8.00
X B. W. Inductance only......... 4.50
X (Not mounted)

For 47 Years Manufacturers of Scientific Instruments

THE PRIDE OF NEW ENGLAND

SE-AR-DE

Clip Coupon for Complete Catalogue of Equipment

Enclose Four Cents for Postage

NAME......................................

ADDRESS......................................

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R. MITHELL & .CO.

257 Atlantic Ave., Boston, Mass.

DICTOGRAPH HEAD SETS

$6.95 Postage Paid

As a result of a special purchase, we offer a limited number of genuine, guaranteed Dictograph Head Phones at the above low price ($6.95), postage prepaid, to any point in United States. Mail money order with your order, at once, to insure prompt delivery.

3000 OHMS

This is the famous Dictograph, considered by Radio experts everywhere as the best in the world. Light in weight—aluminum case—extra super-sensitive 3,000 OHM receivers—very easily adjusted.

Reproduces every sound in crystal clear Natural Tones. Regularly furnished as standard equipment with leading receiving sets. Satisfaction guaranteed or money refunded. Price only $6.95, postage paid.

STANDARD FURNITURE CO.

SEATTLE
WASHINGTON

The WORLD'S BEST HEAD PHONE

MPM

MILLION POINT MINERAL

The Worlds Greatest Radio Crystal

M. P. M. is supersensitive, reproduces from every point on its surface and has record of receiving concerts over six hundred miles. Ask your dealer for M. P. M. or send 50c for two M. P. M. Crystals, concert-tested and guaranteed.

M. P. M. SALES COMPANY
Dept. P. R. 247 So. Central Los Angeles, Cal.

De Forest
D-7
Reflex
Radiophone*

Listen to Half the Continent for 1923!

HERE'S the latest De Forest triumph, the D-7 Reflex Radiophone* Receiver. It's the newest and most sensitive set of them all, with a thousand mile range on a two-foot indoor aerial! That's what you've been waiting for. No outside aerial is needed. The whole set is as you see it here.

Easy to control with its single knob—small, compact, super-efficient—and an ornament to any library table!

Economical to operate, too, because you get five stages of amplification on three tubes, and correspondingly longer life for your storage batteries.

If you want to bring into your home the news, the music, the lectures of half the American Continent—with no trouble—clearly without interfering noises—this is the set for you. And here's one set that is all you ever hoped a receiver could be. Ask your De Forest dealer about D-7 and and other De Forest sets—to-day.

De Forest Radio Tel. & Tel. Co.

Jersey City, N. J.

DE FOREST

*Reg. U. S. Pat. Off.

What is the Finest Receiving Set Made?

To be worthy of this distinction, the set must have three characteristics—

World-wide receiving range—
Reception in all wave lengths—
Reception without distortion.

RadioCraft D-6 Regenerative Radiophone* (by permission of De Forest Radio Tel. & Tel. Co.) will receive even European stations, and of course all those on this continent.

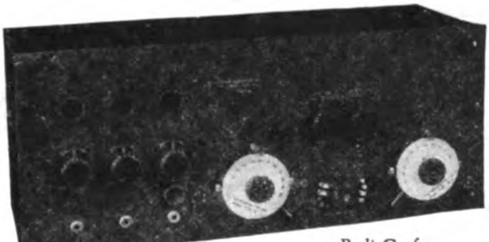
It receives on all amateur, broadcasting, and transatlantic wave lengths.

In clearness and avoidance of distortion, it must be heard to be adequately described.

D-6 uses outside aerial only, and head sets or loud speaker.

It claims to be the finest receiving set now manufactured and any authorized De Forest dealer (who also carries the RadioCraft line) will be glad to prove this to you by actual demonstration.

RadioCraft Regenerative Radiophones*(by permission of De Forest Radio Tel. & Tel. Co.) range from the simplest to the most elaborate.



RadioCraft
Regenerative Receiver
Type D-6

It is unnecessary to add that this entire line of De Luxe radio equipment is most exquisitely finished in every detail.

The RadioCraft Co.

139 Franklin Street, Jersey City, N. J.

RadioCraft

*Reg. U. S. Pat. Off.

Loud Speaker $1

$1

Adapter

Hear all broad-casting through phonograph. Make your own horn. Attach B-R Phonadapter to YOUR phonograph. All can hear. Entire family, neighbors, guests can hear operas, lectures, latest news, with this adapter. Stretches over receiver of Baldwin or Brandes type head-set and attaches to tone-arm of ANY phonograph. Made of soft, pure gum rubber. Quickly attached and removed. Thousands in use. Absolutely no voice distortion. For single receiver.. .75

For pair of receivers (more than twice the volume) $1

Amplitone Loud Speaker

An inexpensive, loud speaking horn especially adapted for home use. Ample volume. Quality tones. Throat of horn consists of successive sound expansion chambers. Each chamber amplifies previous one. Furnished either with single or double B-R Phonadapter. Price only.. $8

Bell Horn

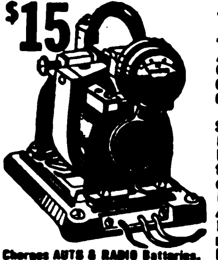
A Bell Horn with ball swivel. Turns up, down, to side—any angle desired. Automatic adjustment. Very simple. No screws, thumb nuts, etc. Black finish. Complete, with phone, ready to attach to two stage amplifier............ $15

The Beckley-Ralston Co.
1825 So. Michigan Ave.
Chicago, Ill.

Go to your dealer. If he cannot supply you send money order, check or currency at our risk. Prompt delivery — postpaid. Also send us name of favorite dealer.

RADIO & AUTO STORAGE BATTERIES CHARGED FROM A LAMP SOCKET AT HOME At a Cost of a Few Cents With An

$15



Charges AUTO & RADIO Batteries.

F-F BOOSTER

A Full Wave Automatic Magnetic Charging Rectifier for 105-125 Volt, 60 Cycle, A. C., Type A-B Charges, 6 Volt, "A" and Auto and up to 120 Volts, of "B" and Loud Speaker Storage Batteries, in Series Inductively at Home Overnight. Disconnecting and Multiple Connections Unnecessary. Charging Circuits Separate. No Grounds. No Danger. NO SKILL REQUIRED. AMMETER eliminates Guesswork. Infusible Electrodes Rectify Current. Will Charge a Dead Battery. Leave Battery Connected, Screw Plug in Lamp Socket, Snap Rectifier Clips on Battery Terminals, Turn Switch and Battery is Charged in Morning. Nothing Like It Made. Is it not Gratifying to Feel Your Radio Batteries are ready for all Radiophone Music and News? Never having to be careful of, or tell friends your Batteries are Dead? Fully Charged Batteries by Starting Car Quick. Require Fewer Expensive Replacements. Do not Think Your Battery is Dead & Worn Out Simply because it will not start Your Car. Buy a Booster which fills it with Life, Saves More Than its Cost and LASTS A LIFETIME. 7 TYPES BUILT By A Master of The Art and POPULARLY PRICED.

Type 6 Charges Radio "A" & Auto 6 Volt Batteries at 6 Amps..	$15
Type B Charges Radio "B" Batteries up to 120 Volts in Series..	$15
Type A-B Charges "A" & "B" Radio & Auto Batteries in Series	$20
Type 12 Charges 12 Volt Batteries at 5 Amperes........	$15
Type 166 Charges 6 Volt Batteries at 12 Amperes........	$29
Type 1612 Charges 12 Volt Batteries at 7 Amperes......	$20
Type 1626 is Combination of 166 & 1612 Charging 6 & 12 Volt..	$28

The Larger Types are for heavy Batteries, or where time is limited. Shipping Weights, 11 to 15 Pounds. Purchase from Your Dealer, or Send Check for Prompt Express Shipment. If via Parcel Post have remittance include Postage & Insurance charges. Or have us ship You Type desired C. O. D. Other F-F BATTERY BOOSTERS Charge Batteries from Farm Lighting Plants and D. C. Circuits. For GROUP CHARGING use our 100-Volt Automatic ROTARY RECTIFIER, 12 Battery, 8 Ampere Size, $135. ORDER Now or WRITE Immediately For FREE BOOSTER BULLETIN 44 and ROTARY 44A.

THE FRANCE MFG. CO., OFFICES & WORKS: CLEVELAND, OHIO, U. S. A.
Canadian Rep: Battery Service & Sales Co., Hamilton, Ontario, Canada

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DELFELCO B BATTERIES

Better Batteries at a Moderate Price

WRITE FOR OUR PROPOSITION

DELFELCO BATTERY CORP.
11 MEETING STREET PAWTUCKET, R. I.

GIVE YOUR EARS A TREAT!—USE

'RED-HEADS'

3000 Ohms

With Military Head-Band and Cord

Now $6.50

At your dealers or direct on receipt of price.

A Triumph in Radio Receiver Design

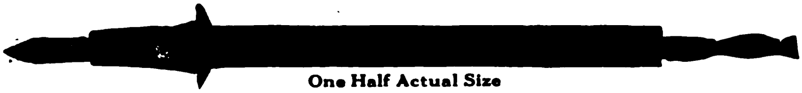
The Newman-Stern Co
Newman-Stern Building
Cleveland, O.

DELICATE SOLDERING

Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tip—Universal Current



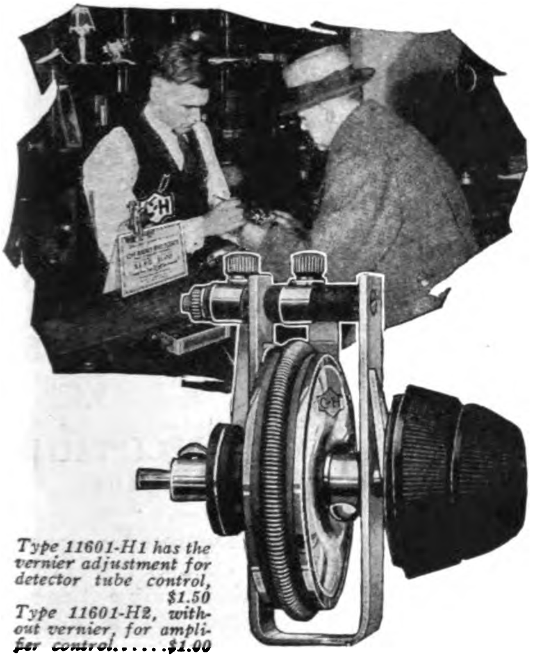
One Half Actual Size

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York



Type 11601-H1 has the vernier adjustment for detector tube control, $1.50
Type 11601-H2, without vernier, for amplifier control......$1.00

Dealers Point with Pride to the C-H Trade-mark

One of the first things any dealer will point out in showing you a genuine Cutler-Hammer Radio Rheostat is the famous C-H trade-mark engraved in the satin-nickel body.

As a practical electrical man, the dealer knows the protection this trade-mark gives the buyer—he knows that "*radio rheostats built by rheostat builders*" means perfection as the result of years of experience, not hasty design to meet a sudden demand.

For more than a quarter of a century the engineers of Cutler-Hammer have been the aggressive pioneers in the development of rheostatic control, and their signature of approval—the C-H trade-mark—is known and respected in every industry the world over.

The dealer is proud to show, as representative of his stock, these rheostats of recognized and guaranteed quality, and he recommends them with full confidence, knowing that they were designed by specialists to give you unfailing satisfaction.

THE CUTLER-HAMMER MFG. CO.
MILWAUKEE - WISCONSIN

Over a Quarter Million in Use

C-H RADIO RHEOSTATS
"BUILT BY RHEOSTAT BUILDERS"

"Member, Radio Section, Associated Manufacturers of Electrical Supplies."

Artists in Your Own Home

could not be heard more distinctly than Radio Entertainers with the

Fada Receiver-Amplifier

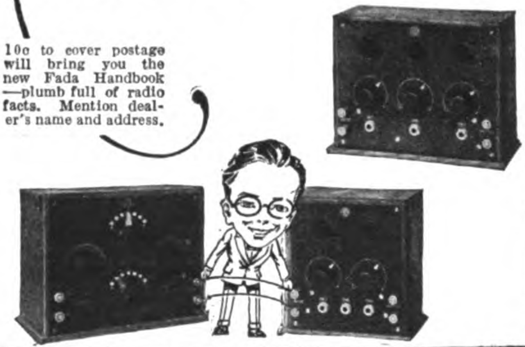
Simplicity of tuning control is an exceptional advantage, and when properly adjusted you enjoy the entire program without giving the instrument further attention.

Tuner can be furnished separate from the Detector and Amplifiers when so desired.

Look for the *Fada* trade-mark when you buy. It's a guarantee of dependable radio equipment.

F. A. D. ANDREA
1581-D Jerome Ave. New York City

10c to cover postage will bring you the new Fada Handbook—plumb full of radio facts. Mention dealer's name and address.



COMPLETE RADIO LINE

Wave Trap
TRADE MARK
PATENT APPLIED FOR

The Missing Link in RADIO

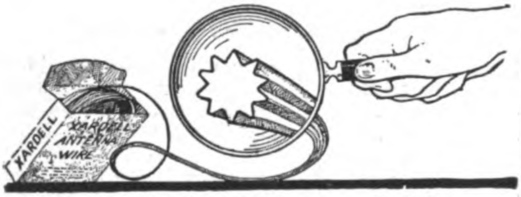
Stops Interference!

Get rid of the interference that is spoiling your evening concert. By using the "WAVE TRAP" you eliminate it.

It is installed in a minute by changing only one connection, and is indispensable on any receiving set with any type of antenna. It is mounted on a formica panel in a handsome mahogany finished cabinet 6x5x6 and is a high grade instrument throughout.

8.50 CHARGES PREPAID

Ferbend Electric Co.
19 E. SOUTH WATER ST.
CHICAGO
Dealers Wanted



Something Brand New in Antenna Wire

$1.50 PER HUNDRED FEET

That will at once appeal to you. It is different and better than any makeshifts to date, being hard drawn from the finest copper having a corrugated surface with 10 collecting points on its circumference. This gives a greater collective and gathering surface. The result is extreme sensitiveness, and an increase in the range and clearness of any set from the simplest crystal type to the finest V. T. Receiver.

Packed in neat cartons of 100 feet, 200 feet and 500 feet.

Dept. C *Postage Paid*

Xardell Corp.
UTICA, NEW YORK

MYERS' AUDION
HIGH-MU
$5.00

RADIO FREQ. CHOKE COILS $5.00

AUDIO CHOKE COILS $3.50

RECEPTACLE $1.00

Make your set compact and efficient at the same time—five times the volume and is absolutely free from tube noises.

YOU CAN GET THEM NOW

SILRAD CO.
639 PAVONIA AVENUE JERSEY CITY, N. J.

DELAWARE CORPORATIONS
ORGANIZED and REPRESENTED
$ 100,000 corporation complete $ 73.00
$ 500,000 corporation complete $113.00
$1,000,000 corporation complete $163.00
24 Hour Service
OUR PRICES AND SERVICE WILL PLEASE YOU.
Correspondence Invited.
Lawyers Corporation Company
"owned and operated by attorneys"
Equitable Bldg., Wilmington, Del.

TAP DRILL SIZES

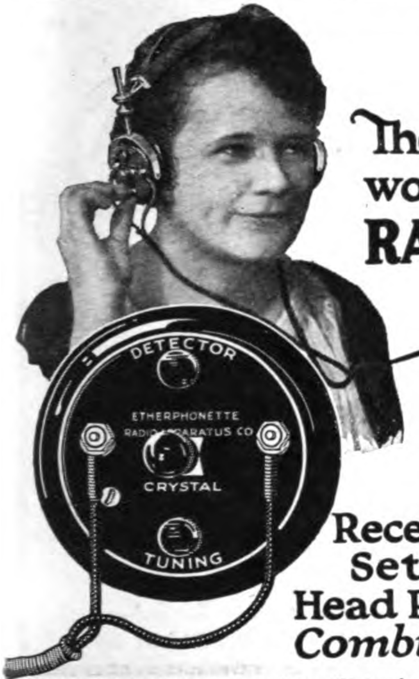
This New Handy Time Saver Disc of screw threads and tap drill sizes will automatically give the correct size of any tap drill to be used when using any kind of a tap. The tap drill sizes for U. S. Standard screws; S. A. E. Standard; tap drill sizes for all pipe taps also tap drill and body drill sizes for machine screws used on radio work together with a complete table of decimal equivalents by sixty-fourths of an inch.

Printed on the very best pressed fibre size 3¼ inches with printed instructions. 15 cents postpaid. Stamps accepted.

HAN—DISC COMPANY—3101 Lyndale Ave. S., Minneapolis, Minn.

ACME
—for amplification
THE ACME APPARATUS COMPANY
CAMBRIDGE, MASS.

Etherphonette



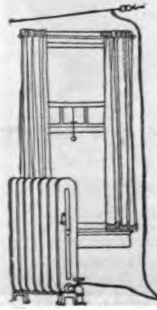
The last word in RADIO

Receiving Set *and* **Head Phone** ***Combined!***

HERE is the most unique "listening in" outfit in the field of Radio. *In the Etherphonette the receiving instrument is built right into the head phone.* No extra equipment is needed. Simply connect to single wire aerial (40 to 75 feet long) inside or outside the home or to lamp socket antenna plug, and ground to radiator, gas or water pipe. Then "tune in."

One shell of the Etherphonette contains a 1500 ohm phone—the other an efficient tuner and concealed crystal detector. Catwhisker, crystal and tuning controlled by outside adjustment knobs. A special eight-foot cord with five foot split ends, and clips for aerial and ground connections, completes the set. Entire Etherphonette is no larger and no heavier than ordinary head phone.

The Etherphonette is not a toy but a practical, scientifically built, radio receiving set. Receives any broadcasting station, sending on 200 to 450 meters, within 18 to 20 miles. An ideal Christmas gift for youngsters or adults.



Price $12.50

If your dealer does not have the Etherphonette in stock order direct from us. We will ship complete Etherphonette parcel post, on receipt of check or money order, or C. O. D., if desired. Money back for your Etherphonette, if within ten days, you are not satisfied.

Order today—be the first in your neighborhood to get the unique Etherphonette.

RADIO APPARATUS CO.
Manufacturers of
"Etherphone" Radio Equipment
40 W. Montcalm St., Detroit, Mich.

BURGESS
RADIO . BATTERIES

—are recommended by leading manufacturers of radio equipment.

—are specified by radio engineers.

—are designed and built by radio engineers.

—are a guarantee of satisfactory service.

—Ask any radio engineer.

BURGESS No. 6 BATTERIES

Are highly recommended for use in "A" or filament circuits where Westinghouse WD-11 Vacuum Tubes are used.

Burgess Radio Batteries are handled by all progressive jobbers and dealers. Look for the distinctive black and white stripes. If your dealer doesn't handle the Burgess line just address the nearest Burgess office below.

BURGESS BATTERY CO.

Engineers — Dry Batteries — Manufacturers
FLASHLIGHT—RADIO—IGNITION—TELEPHONE

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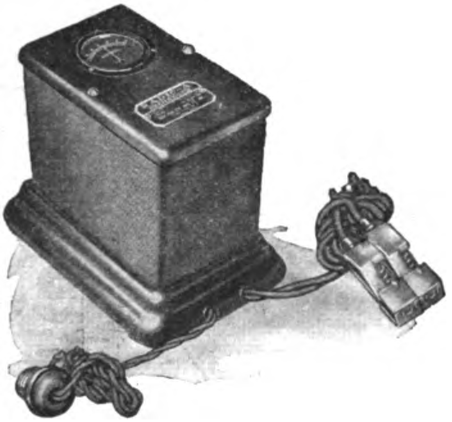
Laboratories and Works: Madison, Wisconsin

BRANCHES:
NEW YORK BOSTON WASHINGTON
ST. PAUL KANSAS CITY NEW ORLEANS

In Canada: BURGESS BATTERIES, Ltd.
Winnipeg, Toronto, Montreal

"ASK ANY RADIO ENGINEER"

BURGESS
RADIO BATTERIES



The Appreciated Gift

RADIO-A RE-CHARGER

The RADIO-A is a highly efficient dependable piece of apparatus, absolutely foolproof, easily attached by simply plugging into ordinary 110 volt lamp socket. In case of current failure, the unit cuts out automatically until current is resumed, without discharging battery.

It is designed expressly for re-charging radio filament batteries, but may be used for automobile or any other storage battery of reasonable size and capacity.

PRICE $18.50

DEALERS & DISTRIBUTORS: Here's a winner. Write us for full particulars.

A compact portable Re-charging Unit that will fully charge a 100 A. H. Battery over night, for from 5c to 10c according to prevailing rates.

Simply screw into any 110 volt lamp socket and connect the terminals to your battery. Impossible to hook-up wrong—RADIO-A charges either way.

LASTS A LIFETIME

KING ELEC. MFG. CO., INC.

1681 FILLMORE AVE. BUFFALO, N. Y.

Best Radio Books *for* Christmas

The Radio Experimenter's Hand Book, by M. B. Sleeper $1.00

Radio Hook-Ups, by M. B. Sleeper .... .75
Indispensable to the radio amateur who designs or builds his own receiving apparatus.

Radio Design Data, by M. B. Sleeper .... .75
Gives tables and data for designing, receiving and transmitting apparatus.

Construction of New Type Trans-Atlantic Receiving Set, by M. B. Sleeper .... .75
Tells how to listen to the high-power telegraph stations of foreign countries.

Construction of Radiophone and Telegraph Receivers for Beginners, by M. B. Sleeper .75
Tells in detail the building of radio apparatus.

How to Make Commercial Type Radio Apparatus, by M. B. Sleeper .... .75
Describes in detail many commercial types of transmitting spark and vacuum tube sets, both telephone and telegraph, and receiving equipment of all kinds.

Wireless Telegraphy and Telephony Simply Explained, by A. P. Morgan 1.50
A book the radio experimenter cannot afford to be without.

Experimental Wireless Stations, by P. E. Edelman 3.00
A book describing all modern improvements.

A B C of Vacuum Tubes Used in Radio Reception, by E. H. Lewis 1.00
A book explaining in detail all about vacuum tubes.

FREE! Catalogue of Wireless Books Sent Free on request.

The Norman W. Henley Publishing Co.

2 West 45th Street, New York

LIBERAL DISCOUNT TO SUPPLY HOUSES
Write for full particulars and dealer's proposition

CHELSEA

Price $40.00

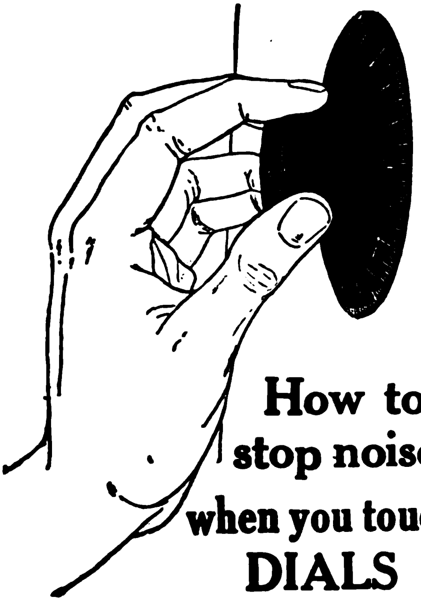
Regenerative Receiver ***A Real Broadcast Receiver***

Licensed under Armstrong U. S. Patent No. 1,113,149. For Amateur use only.

Write for Catalog No. 7 of New Chelsea Radio Equipment.

CHELSEA RADIO COMPANY

152 Fifth Street Chelsea, Mass.



How to stop noises when you touch DIALS

Have you ever found, after tuning in a distant broadcasting station, that when you removed your hand from the dial, there is a growling noise which makes it impossible to hear anything else?

This is usually caused by two things—too much current thru your detector tube filament and dials made from compounds which, being comparatively poor insulators, cause body capacity to make proper tuning an impossibility.

If you are positive that the proper amount of current is flowing thru your filament and these distracting noises still persist they can be overcome only by removing the dials at present on your set and replacing them with dials made of RADION.

Tests have proved time and again that RADION is without question the supreme insulating material for Wireless use.

Secure a dial from your dealer today. Take it home and place it on your set and you'll notice the difference immediately. Also have your dealer show you a RADION MAHOGANITE panel—the most beautiful panel made—easy to saw and drill. It is also warp and chip proof.

If your dealer can't supply you, write us direct, giving us his name, and we'll see that your requirements are immediately taken care of.

INSIST ON

RADION

Dealers Are Invited to Write for Lists

American Hard Rubber Company

11 Mercer Street New York

Perfect Reception

BRANDES *Matched Tone* headsets are the standard equipment of the receivers made by the leading radio manufacturers. The listener judges a radio receiver by what he hears. It follows that Brandes *Matched Tone* headsets must have the qualities that the radio manufacturer demands.

If your receiver is not equipped with Brandes *Matched Tone* headsets, you are not hearing the music perfectly.

Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

Distributors and District Offices:

Munsey Bldg., Washington, D. C.; 709 Mission St., San Francisco, Cal.; 33 South Clinton St., Chicago, Ill.; 76 Pearl Street, Boston, Mass.; 704 Granite Bldg., Pittsburgh, Pa.; 802 Forsyth Bldg., Atlanta, Ga.; 1220 Nicollet Ave., Minneapolis, Minn.; International Electric Company, Wellington, N. Z.

C.Brandes, INC.
Matched Tone Headsets
TRADE MARK REG. U.S. PAT. OFF.
237 Lafayette St., New York
Dept. P. R.

Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric, Ltd., Montreal

Make This a Radio Christmas

"UNITED"
VARIABLE CONDENSERS ARE "JUST ABOUT PERFECT"

In outward beauty—with clean-cut hard aluminum plates ebony Bakelite ends *highly* finished nickeled parts and, in the "beautiful" *work* they do—"United" Condensers are as near 100% good as can be imagined.

VERNIER TYPE
(Like Cut)

Only Vernier with Stop—complete with knob and dial; postpaid:

46 plate	$6.50
26 plate	5.50

PLAIN TYPE
(without vernier, dial or knob)

43 plate	$4.50
33 plate	4.00
11 plate	3.50
5 plate	$2.75
3 plate	2.25

Postpaid

"UNITED"
AUDIO FREQUENCY TRANSFORMERS

"Staple as Wheat" in the radio industry. Magnetically shielded. In a shell of original design and finish—a beautiful piece of workmanship. Ratio 5 to 1. Insures loud clear signals. Fully mounted.

Price postpaid..........$4.50

UNITED MFG. & DISTRIBUTING CO.
536 LAKE SHORE DRIVE, CHICAGO

ANTENELLA
(No Antenna or Aerial Needed)

At your dealer's—$2.00

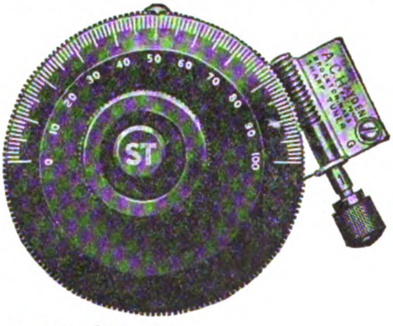
MICON TESTED MICA CONDENSERS

ALL CAPACITIES
Price 25c to $6.00

At your dealer's—otherwise send purchase price and you will be supplied without further charge.

Chas. Freshman Co., Inc.
97 Beekman Street New York City

Use ACH
SHARP TUNER DIALS

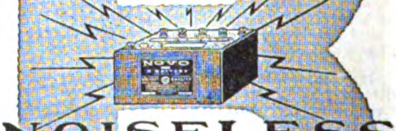


Micrometer adjustment.
Eliminates a vernier condenser.
Locks instrument automatically.
Dial may be grounded reducing body capacity.
May be attached in a moment on any set.
Specify diameter of shaft or inclose 15c for three additional bushings.
Price of ACH Sharp Tuner dial, 3″ size . . **$2.50**

A. C. Hayden Radio & Research Co.
Brockton, Mass., U. S. A.
Mail Orders Sent Prepaid in U. S. A.

NOVO "B" BATTERIES FOR RADIO

22½-45 & 105 VOLTS



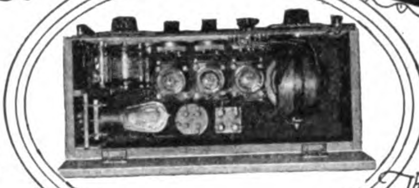
NOISELESS
DEPENDABLE
GUARANTEED

ASK YOUR DEALER

NOVO. MANUFACTURING CO.
424-438 W. 33rd ST.
NEW YORK
531 SO. DEARBORN ST., CHICAGO.

TREMENDOUS DEALER ENTHUSIASM OVER REMARKABLE S-P-2 RECEIVER!

Demonstrated superiority against regenerative receivers, with list price of just $85. Popularity with public, growing in leaps and bounds, makes it the greatest seller on market.

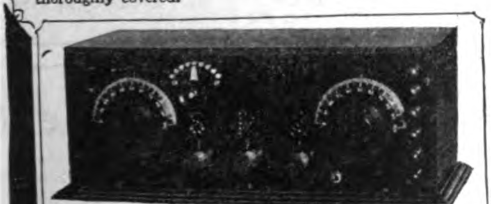


The S-P-2 COMPLETE with ADAPTER

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.



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DEALERS:
Write for Catalogue 101A

PITTSBURGH RADIO SUPPLY HOUSE

963 *Liberty Ave. Pittsburgh, Pa.*

BELL TELEPHONE
GRANT 3632

American RADIO Exposition

The Official Exposition for American Manufacturers

with the endorsement of the

NATIONAL RADIO CHAMBER *of* COMMERCE

and sanction of the Radio Apparatus Section of the

ASSOCIATED MANUFACTURERS *of* ELECTRICAL SUPPLIES

Grand Central Palace

New York

December 21st to 30th

(Sunday excepted but Christmas Day included)

This first really comprehensive Exposition is to be staged in a manner worthy of a great industry. Leading manufacturers have contracted for space. This opportunity to display Radio products to thousands of buyers during the holiday season is an unusual one. The exposition will be one of New York's big features in connection with National Radio Week.

For further particulars write or wire

AMERICAN RADIO EXPOSITION COMPANY
120 BROADWAY, NEW YORK
TELEPHONE JOHN 0009

PRICES SMASHED

Each sale has created new friends and customers, with the result that we now announce drastic reductions in our quality lines. All goods prepaid. Send card for complete list. You'll be surprised. You'll tell your friends. A sample saving follows—

Complete Regenerative Vacuum Tube Set

(Knocked down. Approx. range 1000 miles.)

	Our price	Others
Panel 7" x 12"—Bakelite—drilled	$1.75	$2.50
Cabinet of 3 ply wood to fit above panel	1.50	2.50
Two 3" dials @ 35c each	.70	1.40
16 switch points with nut @ 1c each	.16	.48
4 switch stops with nut @ 1c each	.04	.12
8 nickel plated binding posts @ 3c each	.24	.48
2 switch levers @ 25c each	.50	.90
1 filament rheostat. Highest grade	.65	1.10
1 vario-coupler with 7 multiple, 7 single taps	2.25	4.00
1 23 plate variable condenser. Built right	1.95	3.50
1 tube socket—High grade	.45	.85
1 grid condenser and leak	.10	.25
1 phone condenser	.10	.25
1 support for tube socket	.15	.25
12 feet of spaghetti tubing @ 4c per foot	.48	.84
15 feet tinned copper connecting wire	.30	.45
Blueprints showing details to assemble outfit	.10	.25
	$11.42	$20.12

Other articles taken at random from our list are:

Detector tubes—Cunningham—New. NOT rebuilt	$3.95	$5.00
Crystal detector—Enclosed type	.60	1.00
Transformer—Audio frequency	2.95	4.50
Double slide tuner—Knocked down with wound coil	2.50	
Loose coupler—Knocked down with wound coils	3.75	
Loose coupler—Assembled	7.50	12.50
Variometer—Hardwood stators 4¾" square. Assembled	2.45	4.00
Frost Fones ....2000 ohms	3.95	5.00
Kelloggs ....2400 ohms	8.75	12.00
Western Electric ....2200 ohms	9.25	12.00
Two stage amplifier—Knocked down. Cabinet and drilled panel	12.95	23.50
Blueprints giving detail of two stage amplifier	.10	.25
Two step amplifier assembled and wired with cabinet	18.95	35.00
Vacuum tube receiving set with bakelite panel 7 x 12 in. cabinet. Wired	17.95	33.00

Send for full list today or order from above. Goods sold subject to return for rebate or exchange. YOU SIMPLY MUST BE PLEASED.

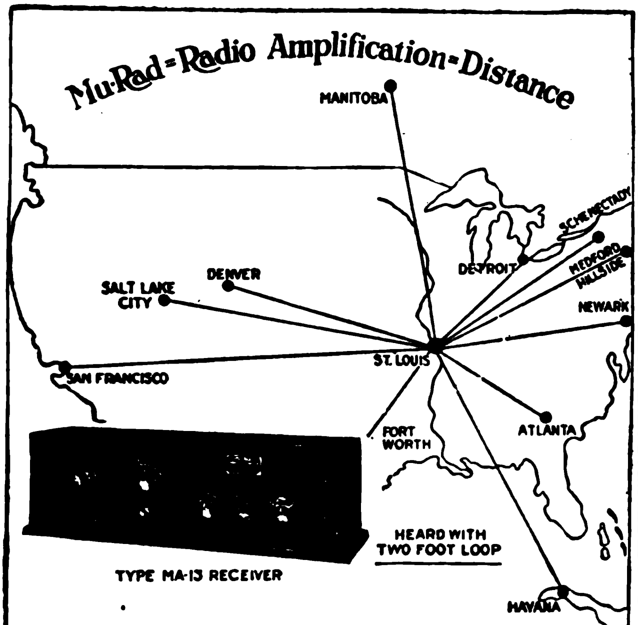
RADIO PARTS MANUFACTURING CO.
17 Park Place Detroit, Mich.

Radio Department

Will lease space for a radio sales department in our retail store, Cleveland, Ohio, on percentage-of-sales basis or flat rental.

APPLY

THE STARR PIANO CO.
1225 Huron Road Cleveland, Ohio



Regular Performance of

Mu-Rad Receivers

The New Star in the Radio World

They copied all they could copy,
But they could not copy our mind;
We left them tearing and swearing,
A thousand miles behind.
—*Kipling.*

INVENTIONS by Mu-Rad engineers are establishing new high standards of radio reception. A Mu-Rad Radio Frequency Receiver with a small loop aerial is more sensitive, more selective, simpler to operate and more compact than any other type of receiving equipment. These are *facts*, determined by impartial tests and comparisons.

Guaranteed for 1000 Miles Reception

We substantiate these claims by a positive, written guarantee on each Mu-Rad Receiver of 1000 miles reception on a loop—another innovation in the marketing of radio receivers.

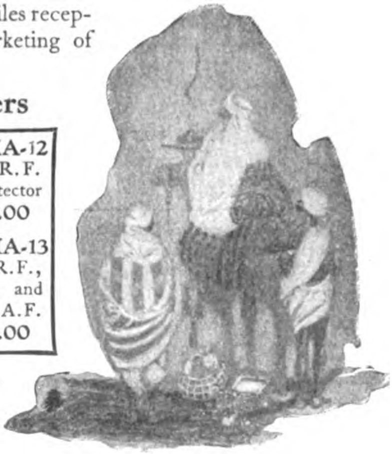
See These Sets at Your Dealers

Ask him to show you their construction and operation. Note the rigid buss wire connections, the high quality workmanship throughout, the fine finish of the mahogany cabinet, the polished Radion panel, the metal dials, the rugged switch, rheostats, condenser and the simplified control.

DEALERS: An attractive proposition is open to dealers in good standing.

Type MA-12
3 Stage R. F.
and Detector
$128.00

Type MA-13
3 Stage R. F.,
Detector and
2 Stages A. F.
$160.00



Mu-Rad Laboratories, Inc.
809 Fifth Ave. Asbury Park, N. J.

The Advice of An Expert

THIS sign on the clean plateglass window of a radio shop means that a competent radio expert is in charge within, who will gladly give you the benefit of his broad experience, in selecting just the radio equipment to suit your purse and purpose.

"It Pays to Buy at the Sorsinc Store"

Mr. Dealer:—If you are a progressive merchant you may display the Sorsinc sign. Let us tell you how.

SHIP OWNERS RADIO SERVICE, Inc.
WHOLESALE DISTRIBUTORS
80 Washington Street New York
Boston, 46 Cornhill San Francisco, 591 Mission St.
New Orleans, 740 Union St. Baltimore, 11 N. Eutaw St.
Seattle, 67 Columbia St.

Yours for the asking—

a free copy of "Chi-Rad's" 1923 loose-leaf catalog. Inasmuch as "Chi-Rad" is a distributor for practically all of the leading radio manufacturers, this catalog will be a convenient and comprehensive review of most of the noteworthy radio parts of recent manufacture.

Mail the coupon below now to be sure that you get your copy—because of constant improvements and price changes in radio parts only a limited number of catalogs have been printed.

Chicago Radio Apparatus Co.
415 South Dearborn Street, Chicago, Ill.

Gentlemen: Please send me, without obligation, a free copy of your 1923 catalog. 102

Name..

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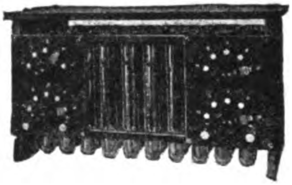

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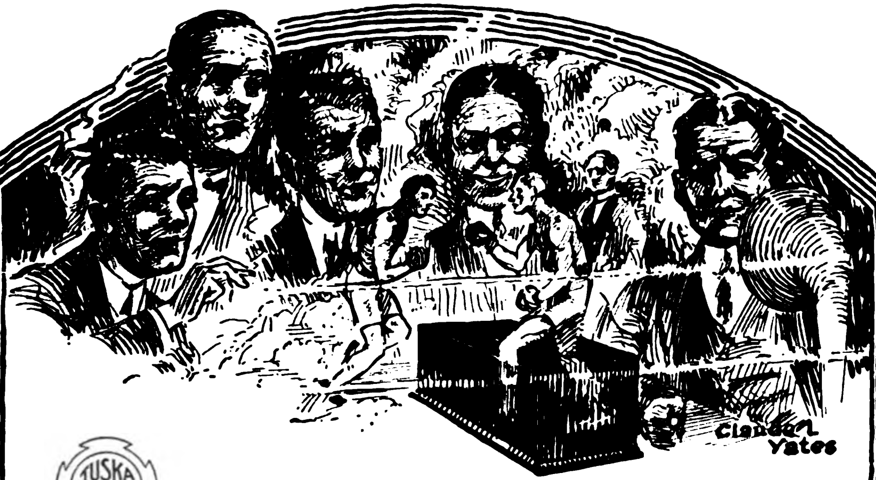

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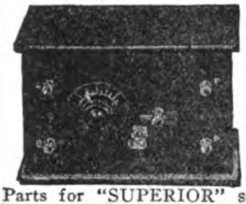

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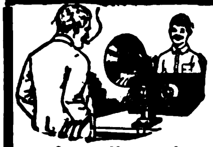

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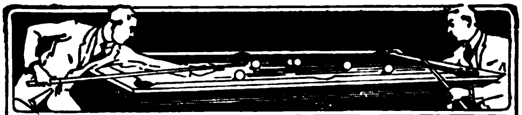

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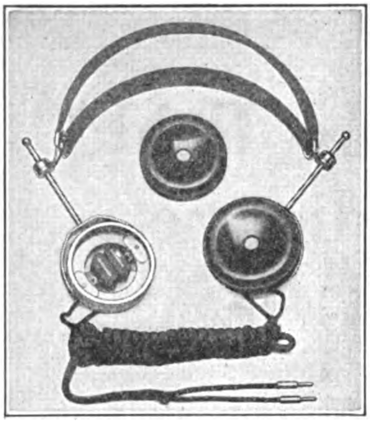

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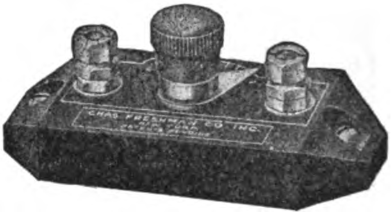

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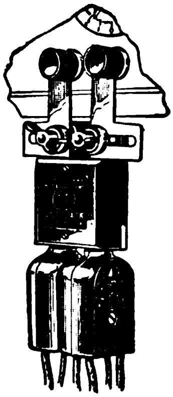

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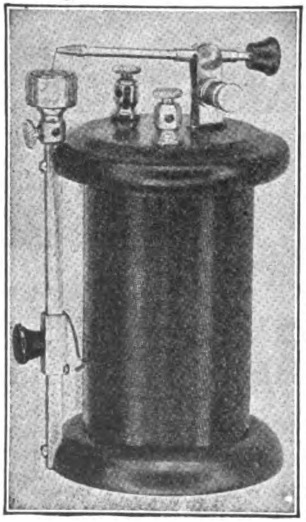
$2.50



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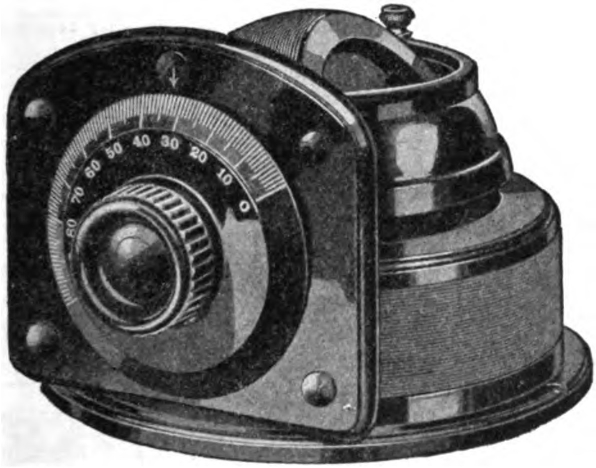

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Popular Radio

FEBRUARY, 1923

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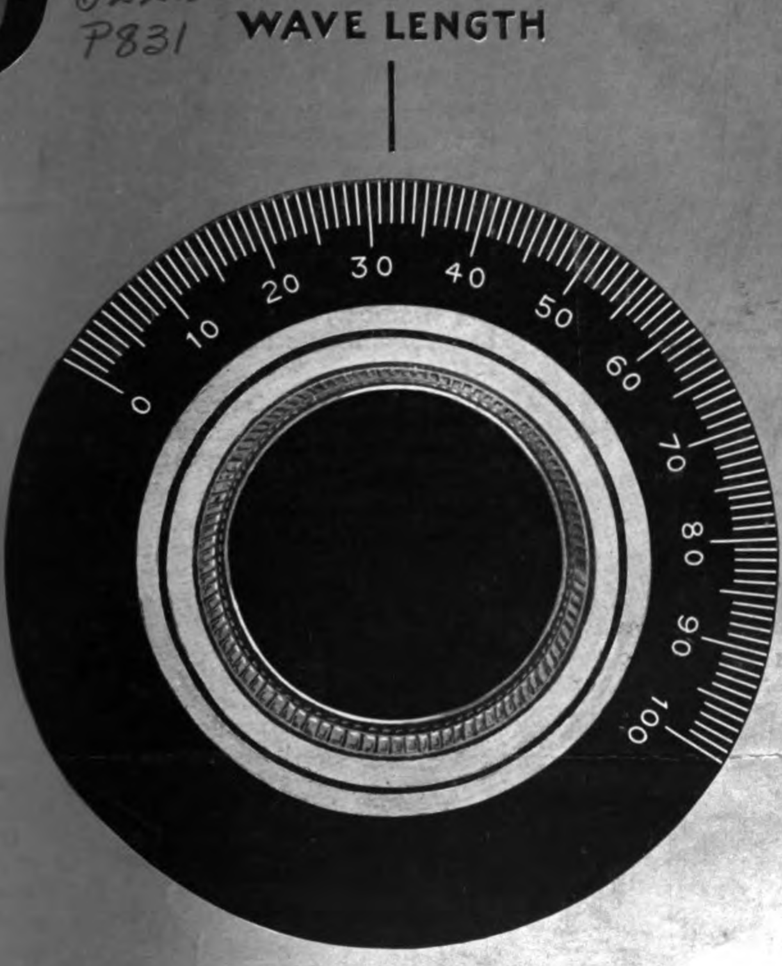

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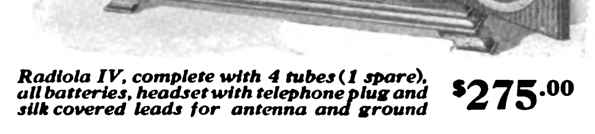

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—Hardwood Box, Mahogany Finish
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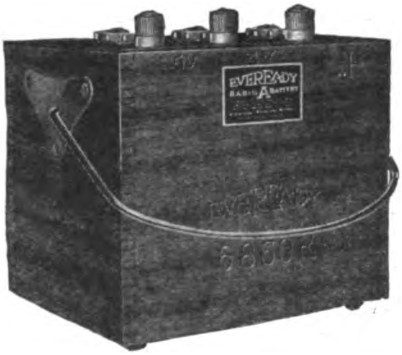
All Eveready "A" batteries are equipped with a 4 volt as well as a 6 volt terminal, making it possible to use either 6 volt or 4 volt vacuum tubes in your set



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POPULAR RADIO

EDITED *by* KENDALL BANNING

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VOLUME III FEBRUARY, 1923 NUMBER 2

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

"The wise man looks into space, and knows there is no limit to dimension." said Chuang Tzu.

The wise Radioist bridges the greatest distances with a Grebe Receiver.

Doctor Mu.

A LONG RECORD of unequalled performance has won for the Grebe Receiver the unqualified endorsement of all good dealers.

"Musings of Doctor Mu"—the story of the development of the Perfect Receiver, free upon request.

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A PAGE WITH THE EDITOR

In the next issue of Popular Radio the Editor will spring a rare treat upon our readers. He has been quietly working on this March number for six months—not daring to announce it for fear that some accident might upset his plans. But at last his hopes have been realized—and next month he will present our readers with an "All-Star Number."

* * *

The March issue will be the first All-Star number ever issued by any radio magazine —or by any technical or semi-technical magazine, so far as the Editor knows. Every contributor is a scientist of international fame—and each has written an article that is a real contribution to the literature of radio. Glance over this partial list of contributors; it includes the leading radio scientists of the entire world:

Senator Guglielmo Marconi
Dr. Lee De Forest
Sir Oliver Lodge
Hiram Percy Maxim
Major-General George O. Squier
Paul Godley
Prof. James Arthur Fleming
John Hays Hammond, Jr.
John V. L. Hogan

This is incomparably the greatest list of radio experts ever assembled in one issue of any periodical.

* * *

"I never supposed that any periodical other than the journal of a scientific society could bring together the writings of so many distinguished men as Popular Radio has done," writes Hall Shepherd of Vanderbilt University.

* * *

This number of Popular Radio which you are holding in your hand is just exactly *double the size of our number of ten months back!*

This 100 percent growth has been as remarkable as it has been inevitable. Such a wealth of new and valuable and timely articles has been crowding into the editorial sanctum that the Editor can no longer hold it back in the files to await its turn for publication. It simply *has* to be presented to our readers while it is fresh—when our readers can profit from it most.

The demand of our readers, *"We want more* Popular Radio," has been answered.

* * *

Radio sets or parts that are forwarded to Popular Radio will be distributed without charge in those veterans' hospitals that can use them to best advantage. What other good fellows will help to let our disabled soldiers to listen in on the ether?

* * *

"Every day, in every way, Popular Radio is getting better and better," writes Noble Foster Hoggson, of New York, in paraphrase of the famous *dicta* of Dr. Coué.

When a disabled soldier in a veterans' hospital in Trenton, New Jersey, appealed to Popular Radio for a receiving set to help him while away his otherwise dreary hours, he started a chain that the Editor hopes will encircle the country. Through the generosity of a reader, Cyril Nast, the Trenton veteran had his wants satisfied.

* * *

Popular Radio's appeal to its readers for radio sets or parts to be presented to other veterans' hospitals has not fallen on deaf ears. The latest gift of radio parts comes from O'Donnell Brothers of Morris Run, Pa., and has been delivered to the U. S. Veterans' Hospital in the Bronx, New York, with the grateful approval of Dr. A. P. Chronquest, the Senior Surgeon.

* * *

Last month the police arrested a man on Broadway for selling fifty-cent pieces for a quarter.

What will the police do when they discover that we are selling Popular Radio for only 20 cents?

* * *

As evidence that Popular Radio's efforts to serve the interests of the radio fans of the country (which is another way of saying the "radio interests" of the country) is not confined to mere discussion and preachments—turn to page 120 of this number and read of the practical, constructive efforts to develop broadcasting with which this magazine is actively associated.

* * *

The transmission of symphonic music from the concert auditoriums to the broadcasting station by means of telegraph wires (instead of by the usual telephone wires) marks an innovation. And to prove that it *could* be done, Popular Radio and station WJZ got to work and *did it*—and did it better than has been done before by the telephone wires, according to reports.

* * *

Only hold-ups, murder and sudden death prevented Albert Bahr of Kansas City from promptly renewing his subscription to Popular Radio; as it was, his renewal came along nearly a week later than he intended. "It was neglected," he apologizes, "owing to the excitement over the robbery of my son-in-law's grocery and the murder of both him and his twelve-year-old son, who were shot at the time. Enclosed find my renewal subscription."

Well, we'll overlook the delay this time, under the circumstances.

Kendall Banning

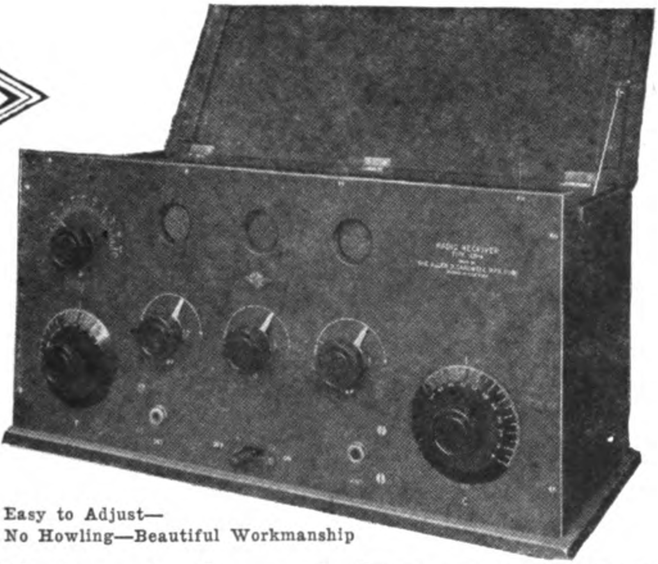
Editor, Popular Radio

CARDWELL PRODUCTS

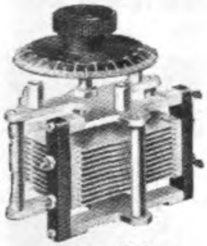
RECEIVER

TYPE 125A

Double Circuit, using primary condenser; detector; two stages of audio, one radio frequency. Solid mahogany cabinet. A highly efficient long-distance set. Range 200 to 700 meters. Price $125.00



Easy to Adjust—
No Howling—Beautiful Workmanship



Type 123A

Radio Frequency
Type 104A

Cardwell Condensers Are Guaranteed

superior to others of similar type in the following respects.

Mechanical Construction—(All-metal frame. No insulated bushings.) Frame exceptionally rigid. Permanent alignment of plates.

Roto—Zero Potential to Frame—"Body capacity" and leakage practically eliminated.

Minimum to Maximum Capacity—Greater range than any other of equal plate area.

Dielectric—Entirely outside the electrostatic field.

Dielectric Loss—Reduced to the minimum. Less than ¼ square inch total area of contact between fixed plates and dielectric mounting strip.

(Eminently Superior for **Loop** sets.)

Adaptability—Condenser can be mounted on metal without bushings or on dielectric panel without changing capacity or increasing dielectric or leakage losses.

Price $4.75 Less knob and dial or Price $5.75 with knob and dial

A low price for a really superior instrument of (.0005 mfd. capacity.)

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BUREAU OF STANDARDS
WESTERN ELECTRIC CO.

The same rigid supervision and inspection that governs the above is also enforced in the manufacture of sets and parts for amateur use.

RADIO FREQUENCY—Range 200-500 Meters

Genuine moulded bakelite case. Correctly designed—low capacity—efficient winding. Will increase the receiving range of a set enormously. **Price** $4.50

AUDIO FREQUENCY—Ratio 9 to 1

Vacuum impregnated windings, specially treated silicon steel laminated core. Possesses excellent amplifying qualities, free from distortion. Operates well with all tubes. **Price**................ $5.00

Audio Frequency
Type 124A

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The Allen D. Cardwell Manufacturing Corporation

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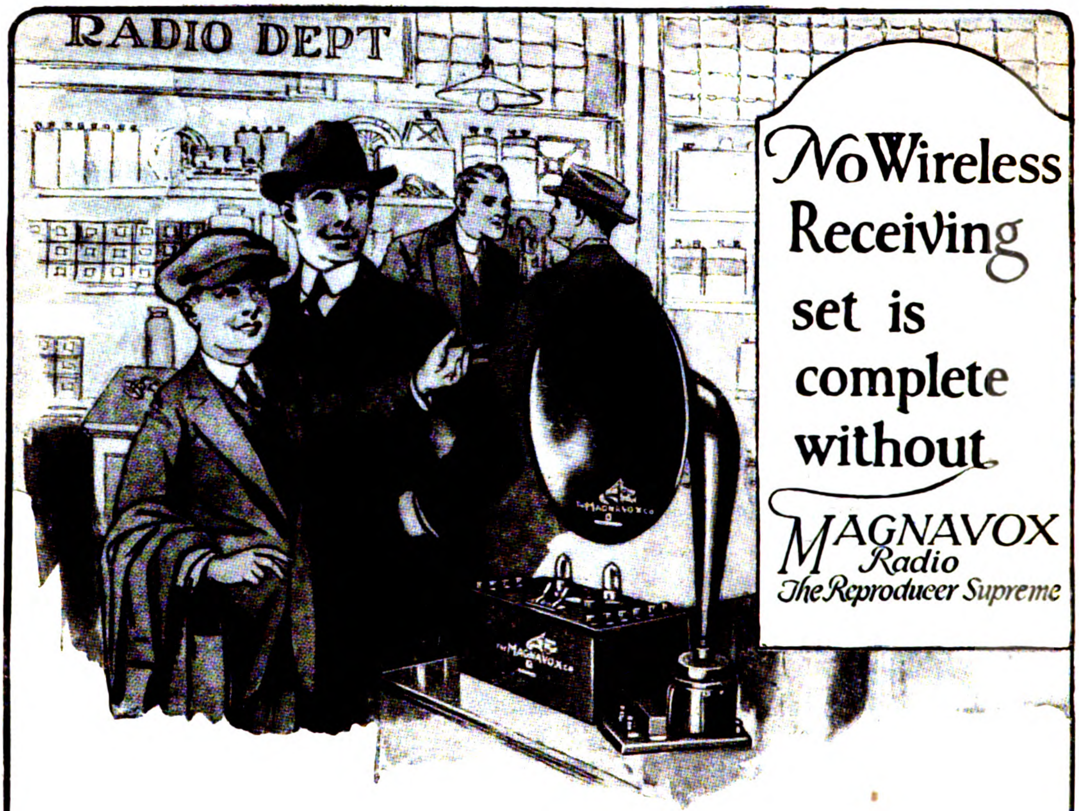


R-2 Magnavox Radio with 18-inch horn: this instrument is intended for those who wish the utmost in amplifying power; for large audiences, dance halls, etc. $85.00

R-3 Magnavox Radio with 14-inch horn: the ideal instrument for use in homes, offices, amateur stations, etc. $45.00

Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Radio. 2 Stage . $80.00
3 Stage . 110.00

When you purchase a Magnavox product you possess an instrument of the highest quality and service.

Magnavox products can be had of good dealers everywhere. Write us for copy of new illustrated booklet.

EVERY improvement in the science of radio broadcasting and reception only emphasizes the truly extraordinary qualities of Magnavox.

To enjoy all that radio offers in the way of daily concert, lecture and news, ask your dealer for a receiving set equipped with the Magnavox Radio Reproducer and 2-stage Power Amplifier.

Magnavox can be used with any good receiving set—the better the set, the more Magnavox can do for you.

The Magnavox Co., Oakland, California
New York: 370 Seventh Avenue

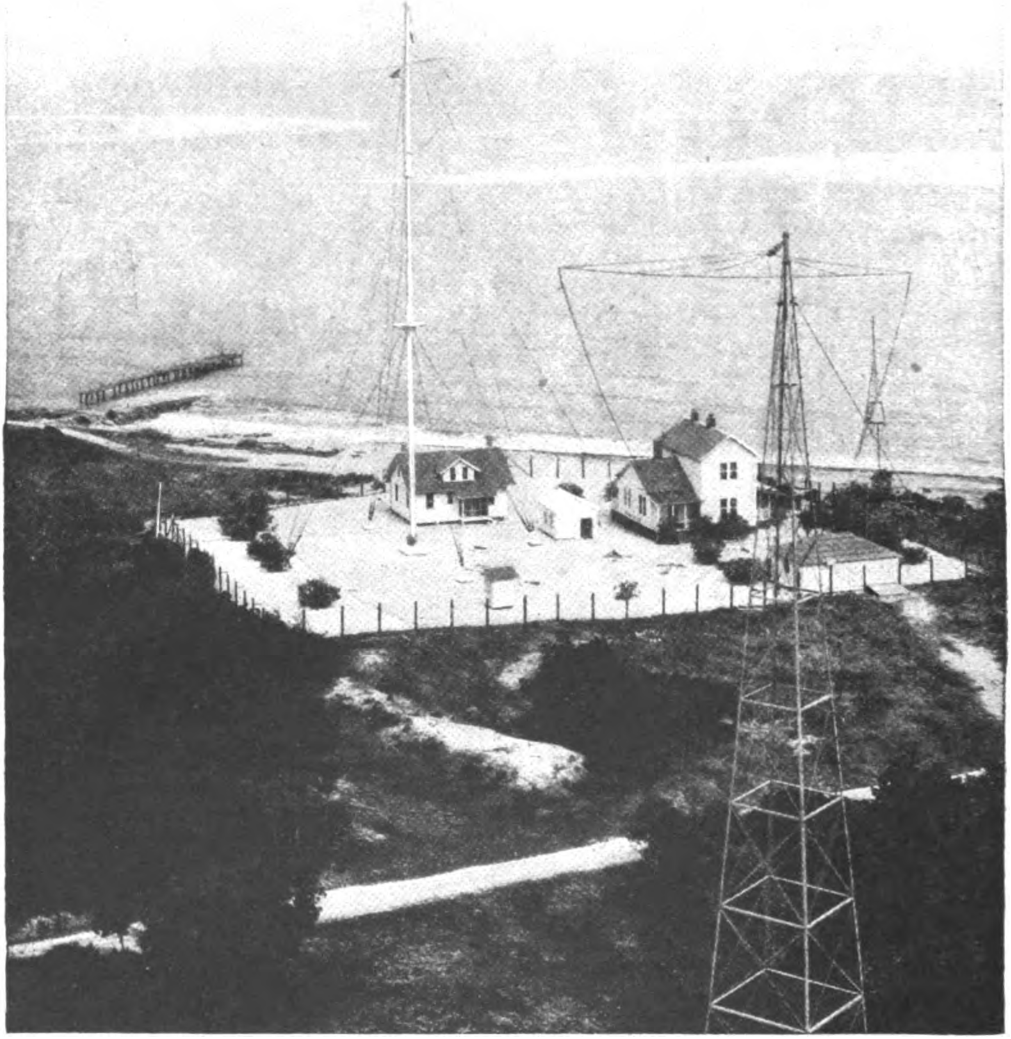
From a photograph made for POPULAR RADIO

Important—to All Amateurs!

"I am writing a series of articles for POPULAR RADIO *on points concerning which amateurs would probably be glad to get information. . . . I write not for mathematicians, nor yet for beginners, but aim at boiling down the results of mathematics into popular form suitable for amateurs who want to understand the principles of what they are doing, and who are constructing parts of their own apparatus."*

Oliver Lodge

This new series of articles by Sir Oliver Lodge begins in the next issue—March.



U. S. Navy Official

The Voice That Carries Around the World

From shore station to shore station, from ship to ship, "orders from headquarters" are transmitted by radio telegraph to any point on the globe where Uncle Sam's naval emissaries are permanently or temporarily located. This picture shows a representative Naval Radio Station, at the edge of the tropics in St. Augustine, Florida.

Popular Radio

VOLUME III FEBRUARY, 1923 NUMBER 2

"Clear the Ether!"

What the Navy Is Doing for Better Broadcasting

No radio amateur need be reminded of his novice days when, with his crude set, he was unable to tune out the incessant "interference" from the powerful radio stations of the Navy. This interference came from two sources: (1) from the high-powered arc transmitters which caused harmonics and (2) from the land and ship spark stations which emitted broad waves. How the Navy is clearing the ether of this bug-bear—to the gratification of the radio fan—is told in this article.

By COMMANDER S. C. HOOPER, U. S. N.

TWO years ago the government surveyed its shore naval stations, equipped with the most modern types of apparatus, with considerable pride and satisfaction. All the needs of radio communication between ship and shore, transcontinental and transocean were being met and it was felt that the spark equipment would suffice for many years to come, that the apparatus represented the last word in practical radio equipment.

Quenched spark transmitters were installed at coastal radio stations for communication with ships at sea and arc transmitters were provided for the transoceanic and transcontinental shore radio stations. These two types of transmitters were the only transmitters which were known to the art as being rugged, reliable, flexible in wavelength range and economical to maintain. The required transmission ranges were obtained with these transmitters and the selectivity was such that stations situated from fifty to two hundred miles from each other did not produce waves which interfered with the proper handling of traffic.

Up to this time vacuum tube transmitters were in an embryonic stage and there was considerable doubt as to whether this form of transmitter would ever be developed so that powers in excess of a few watts energy could be produced reliably. It is true that higher powered vacuum tube transmitters were in existence, but such transmitters had not been subjected to service tests over long periods. In such a state of development it was thought that it would be many years before the vacuum tube transmitter would be suited for continuous, reliable service, such as is required for shore radio stations.

This statement is based on the results obtained during the extensive development work undertaken by the Navy, in collaboration with commercial companies,

From a photograph made for POPULAR RADIO

"MOST OF THE COMPLAINTS ABOUT THE NAVY'S INTERFERENCE WERE TRUE"

So frankly reports Commander S. C. Hooper, in charge of the radio research department of the U. S. Navy. So the Navy promptly got to work to remove the causes.

on vacuum tube radio telephone and telegraph transmitters. In this work much time, effort and money was expended by the Navy to produce reliable vacuum tube equipment, but the Navy could not conscientiously place this equipment in service without the fear of expending large sums for maintenance.

Like an avalanche, the radio telephone craze came into vogue and everybody interested in this new type of entertainment bought a receiver. It did not matter what kind of a receiver was bought so long as the radio telephone concerts could be heard. Immediately from different points along the coast where naval shore radio stations were situated, inquiries began to come from the public about the interference experienced from these transmitting stations.

With these inquiries came various statements from different persons, to the effect that the Navy quenched spark transmitting stations were obsolete and inasmuch as they were a public nuisance they should be scrapped and new equipment installed. This was most likely brought about by the close associations of the radiophone enthusiasts with the reception of continuous wave signals, which naturally are sharply tuned. They compared the broad wave from the spark transmitter and the sharp wave from the radio telephone or continuous wave transmitter and then drew their own conclusions on the antiquity of the Naval quenched-gap transmitters. They did not, however, realize that the radio telephone transmitters to which they were listening were going through a stage of experimental development work at the cost of considerable sums of money in the development of high-power vacuum tubes. The method pursued in the experimental development work on radio telephone transmitters was suitable for the purpose of introducing the new entertainment, but equipment so developed could not be installed at shore radio stations where reliable transmitting ranges were required at all times, without saddling the taxpayer with undue expenses.

Tied in with the complaints on spark transmitters were a limited number of complaints on the interference caused by "mush" and harmonics emitted from arc transmitters at high-power shore radio stations. These complaints came from districts within a twenty-mile radius of the high-power stations. All the complaints were found to be true.

According to all communication laws, the handling of radio traffic is given priority over all experimental or other work.

The government realized the priority of radio traffic, but in order to remedy conditions, immediately set about to devise methods for removing the cause of the interference.

A thorough survey of the situation was made, and it was decided that the quenched-spark apparatus, considered the most modern a year previous, must ultimately be considered as a thing of the past and continuous wave transmitters

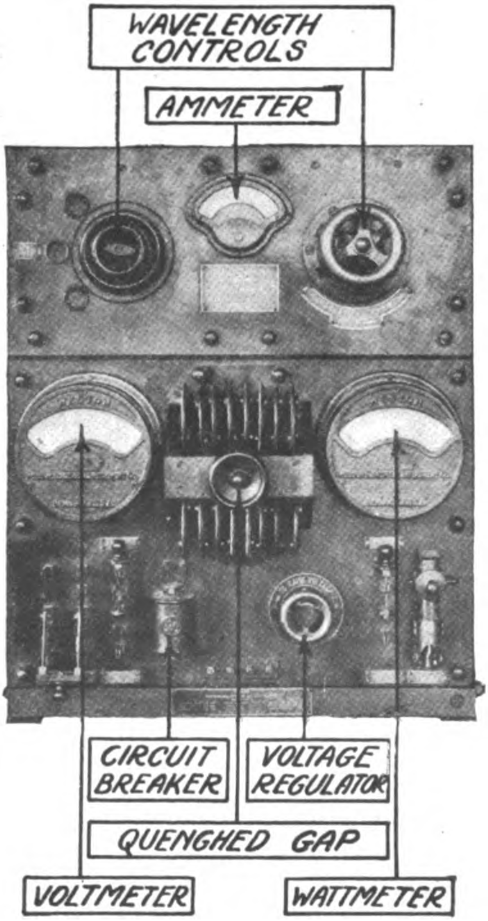
Brown Bros.

ONE OF THE CAUSES OF THE RADIO FAN'S TROUBLES

One of the giant tuning coils used to transfer energy from the generators to the antennas of the Navy's radio stations, and the source of the "mush" or harmonics that disturb the small receiving sets. The Navy's radio engineers have developed several methods for eliminating "mush," the adoption of one of which will solve the problem.

must be made standard. It was also decided that steps should be taken to eliminate the emission of mush and harmonics from high-power arc transmitters. If it was not possible to eliminate the harmonics and mush from such transmitters, steps should be taken to replace these transmitters with high-frequency alternators or high-power vacuum tube transmitters.

This decision was an important one, but it needed considerable thought on the part of the government, for the scrapping of the existing equipment on naval ship and shore stations and the replacement of such equipment by continuous wave transmitters would cost the taxpayer approximately $5,000,000, possibly more



THE DISCARDED SPARK TRANSMITTER

This apparatus is being remodeled as shown on page 75. This type causes the interference with which most radio fans are familiar.

For shore stations alone this would have amounted to at least one-third of the sum mentioned. How would the taxpayer consider such an expenditure when at the time the cry of the people was to reduce the taxes?

Numerous conferences were held in which the research and design engineers of the Navy Department were present. The outcome of these conferences was the adoption of the following procedure:

(1) To convert the existing spark transmitters to the new type vacuum tube transmitter, which employs the high voltage alternating current produced in the secondary of the transformer of the spark transmitter. This type of transmitter is now called the "Alternating Current Vacuum Tube Transmitter." Such a transmitter would employ the same power equipment as the spark transmitter and with the exception of the vacuum tubes and fittings would be identical to the original spark transmitter.

This change-over required considerable development work, but within the space of one year the work was completed, and after severe tests the new apparatus was finally accepted as a practical transmitter. Various sizes of this type of transmitter were made and were immediately installed on ships and at shore radio stations.

The illustration on this page shows a Navy standard ½ K. W. spark transmitter, while that on page 75 shows the same transmitter remodeled into a vacuum tube transmitter. The remodeled transmitter has a transmitting range which is twice that of the spark transmitter. This assertion is based on results obtained during practical tests when equal power input was supplied to both transmitters.

The expenditure involved in changing over the spark transmitters to vacuum tube transmitters was found to be ap-

HOW RADIO IS USED ON UNCLE SAM'S DESTROYERS

So successful was the Navy's experimental work with the radio telephone during the war—especially on vessels of the destroyer class—that it proved to be a factor in creating broadcasting as we know it today.

proximately one-third the cost of a new vacuum tube transmitter. The big saving, as the result of this policy, can be easily understood when it may be stated that a saving of $1,000 a transmitter on each ½ K. W. transmitter was obtained. A total of $300,000 was saved in remodeling fifty ship sets from spark transmitters to vacuum tube transmitters.

In view of the achievements accomplished in the saving of such sums of money, it was decided to proceed with the work of altering all spark transmitters to vacuum tube transmitters, and to alter as many sets a year as funds were available from other projects. This plan is now being carried forward and at the present time alterations have been authorized for at least one hundred ship sets.

The Navy Department further decreed:

(2) That intensive research work was to be proceeded with to eliminate the compensation wave from arc transmitters and also, if possible, to eliminate or reduce the arc mush and harmonics.

This work has practically been completed, thanks to the untiring efforts and brilliant work of Naval radio engineers. The single wave method of transmission for arc transmitters of all sizes up to 500 K. W. is a success and at the present time is in operation at numerous Naval ship and shore stations.

Various methods of eliminating arc mush and harmonics were tried at Navy Yards and also at high-powered shore radio stations. Virtually, this investigation was assigned to several Navy Yards and radio laboratories with the hope that some engineer would devise a suitable method of accomplishing this tremendously important objective. At first the problem seemed to be too big to solve, and it caused considerable worry to the engineers engaged in this work. They tried this method and then that method, but they seemed to come back again to the place where they started. It was discouraging work and it required more patience than even the proverbial fisherman is said to have had.

But after many months of brain-racking work a solution was found. A great sigh of relief was given when it was proved that this problem was solved, for if it had not been, the scrapping of millions of dollars' worth of arc transmitting equipment would have been necessary.

The new equipments are now being given service tests to compare the relative efficiency of each of the various successful methods of eliminating harmonics and mush. The best method will be adopted and installations will be made as soon as funds are available. It is believed that the arc transmitter will be so modernized that it will radiate a pure wave and all interference caused by these transmitters eliminated to the satisfaction of the public.

By virtue of the expenditure of approximately $15,000 in research work, the Navy has saved its arc systems from being scrapped. This scrapping, as previously stated, would mean a waste of millions of dollars' worth of equipment. In the saving of this equipment the Navy, through necessity, has contributed much to the advancement of radio in general and broadcasting in particular.

I estimate that it will require at least three years for the government to modernize its radio equipment to the extent that no further complaints will be received from the great army of radio fans, concerning unnecessary interference due to Naval transmitters.

It must be realized, of course, that the

Edwin Levick

ONE OF THE PUBLIC SERVICES RENDERED BY THE NAVY'S RADIO MEN

When Uncle Sam's sailors undertook to furnish position reports to vessels approaching our shores, they vastly facilitated navigation—and they are doing it without charge. Here is a navy operator reading the direction of a ship at sea by means of the radio compass.

producers of radio sets for radio telephone broadcasting stations and the amateur must share their portion of the responsibility in keeping the air clear and at the same time remaining within the assigned band of wavelengths.

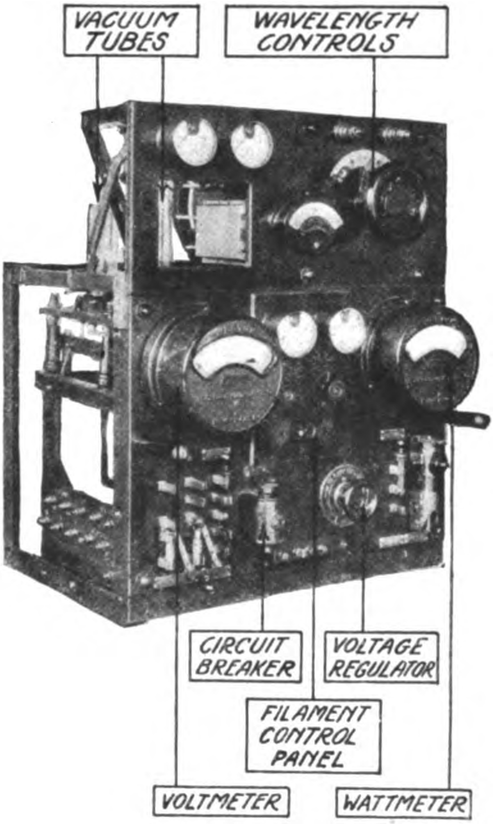
This will not be as easy a task as it at first appears, particularly the problem of keeping the wavelengths of transmitters fixed. This assertion should be carefully weighed, as it has been the Navy's experience that the wavelengths of transmitters must be checked daily and if necessary the transmitters must be recalibrated; otherwise they are subject to wide errors. Indeed, the Navy makes a practice of carefully checking the wavelength of each radio transmitting system, especially those at the high-power radio stations. This results in keeping all Naval high-power stations always on their assigned wavelengths.

At no time is a Naval station allowed to transmit on a wavelength that is more than one-half of one percent off the assigned wavelength.

Although the transmitting equipment presented an extremely hard problem to solve, there also was a need for improvement in receiving equipment, whereby greater selectivity could be obtained. With the increase in the number of high and low-power radio stations in this country and abroad it became imperative that selective receiving apparatus be employed in order that radio traffic could be expeditiously handled with the minimum amount of interference.

After careful study of the problem it was decided to use receiving systems which involved the combination of loops and antennas with an extra tuning device for weeding out interference and static. Resort was also made to a separate heterodyne for the reception of both medium and long continuous wave signals.

The question whether it is advisable to continue the use of regenerative receivers, especially when these receivers while oscillating are miniature transmitters, is a difficult one. It has been suggested that the regenerative receiver be retained and provision made to add an additional vacuum tube transfer circuit between the antenna and the receiver, which connection would stop the emission of interfering signals. This has been considered, as also has the use of a radio-audio frequency amplifier with separate heterodyne.

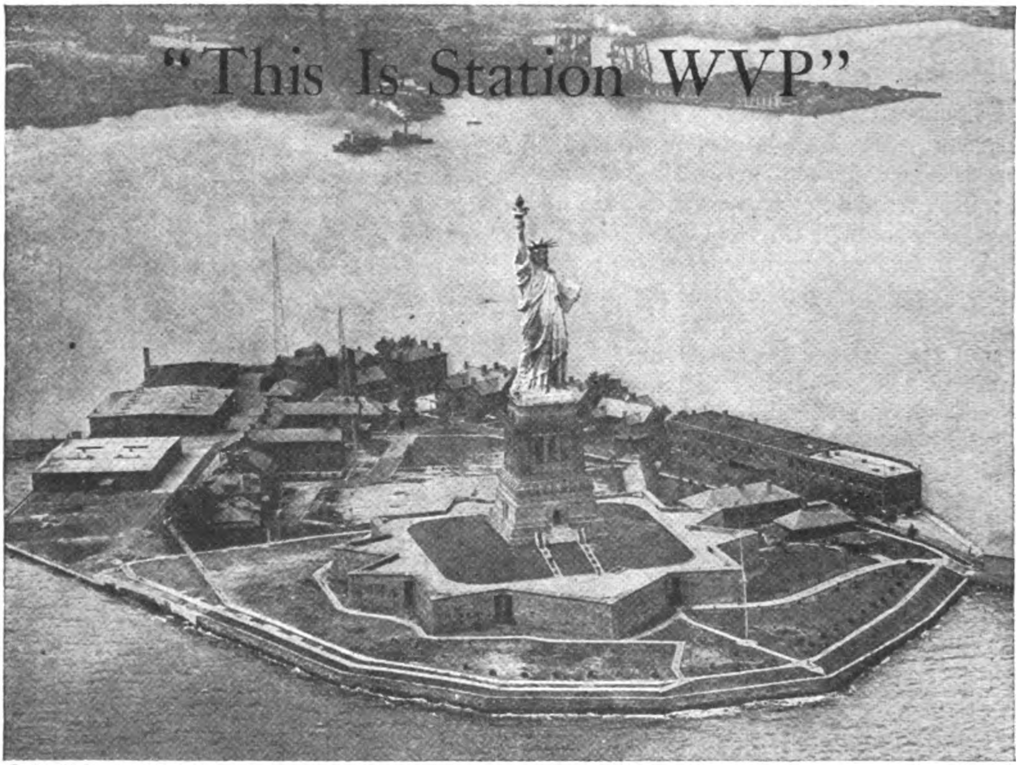


THE NAVY'S NEW TRANSMITTER

This is the converted equipment which used to employ a spark but which now employs vacuum tubes that send out radio waves of exceptional purity.

Superhuman efforts are being made by the Navy to keep the Government equipped, at reasonable expense, with a radio system that is as near 100 percent efficient as is possible, and at the same time, in order to merit the good-will of the radio amateur, to keep the service beyond reproach.

"This Is Station WVP"



© by Major Hamilton Maxwell

Six nights a week the Army's radio station at Fort Wood is operated by the Amateur Radio Reserve*—an organization that is casting a radio net over the entire country. This article tells how it started and what it is doing.*

By HOMER CROY

ON the south side of Gramercy Park, New York, is a club frequented exclusively by men—The Players. Here each noon writers, actors and artists of distinction gather for their midday meal. In a corner is located a group that is known as "the Round Table," which indulges in much gay banter.

On one occasion this group included two men. One was round-faced, with hair tinged with gray, rather portly of body and with a quick, unexpected laugh—and the smoker of a great many cigars. The other man had a blond, bony face overhung with thick eyebrows and gold glasses, an artist, but also an ardent radio fan—since the days when radio was just finding its toes. It was William Andrew Mackay (2AQB), the creator of the Mackay system of naval camouflage. He was telling how each night, from his home in Coytesville, New Jersey, he listened to the great chatter going on in the air, wholly unknown to the general public. He told how he himself had spoken into the night, talked with persons he had never seen, how he had become acquainted with his phantom friends, carried on long conversations with them, yet hadn't the slightest idea what most of them looked like. The Round Table listened soberly; there were no irrelevant remarks. It was unusual.

Across the table from the speaker was the round man with the graying hair, puffing at his cigar. During the war he had served as a major, and now, although back in civilian life, he was quick to think of the interests of the army. The man was Lieutenant-Colonel Kendall Banning.

"Isn't there some way of recognizing all these radio fans and of organizing them so that they could be of real service to the army?" he asked.

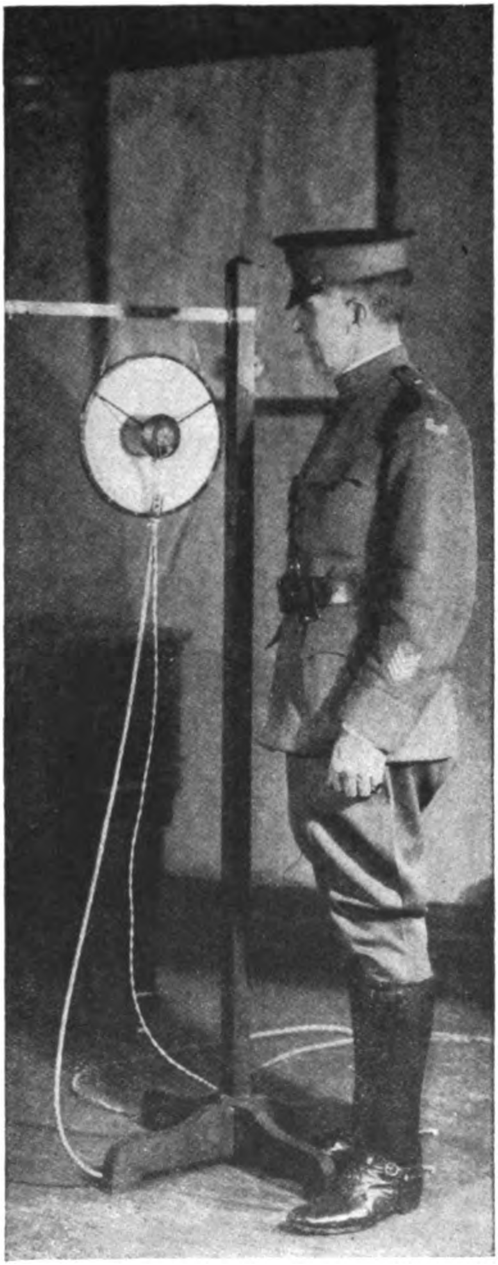
So the idea was born.

In a few days it was presented to Colonel Edgar Russel, who served as the chief signal officer of the A. E. F. The Colonel was interested; saw the possibilities. A call was sent out for a meeting of the radio amateurs, including some of the chief figures among them. They gathered in Colonel Russel's office, where many of them saw each other for the first time—these men who had been acquainted so long. The meeting was called to order, an organization was effected, and the name "Amateur Radio Reserve, 2nd Corps Area, United States Army" was chosen. It should be under the guidance of the army, yet not of it; it should be next of kin, yet not related; the army should be its big brother, yet not want to boss it. An executive council was appointed, with Dr. Alfred N. Goldsmith as chairman. Charles J. McBrearty was made secretary, and to his long and industrious hours much of the development of the organization has been due.

The baby forthwith started to grow, to gurgle, to grab things on the wall.

The United States is a big and powerful country, but often it has strange economies. After the war was over Congress peeled the Signal Corps to the bone. The appropriation for telephone and telegraph communication of the 2nd Corps Area was cut down to $1,200 a year, which was hardly enough to keep in it the breath of life. Communication had to be kept open. The post office was resorted to. Messages which had once gone by wire were now sent out with good wishes and a stamp.

And then the Amateur Radio Reserve walked in. It said:



International

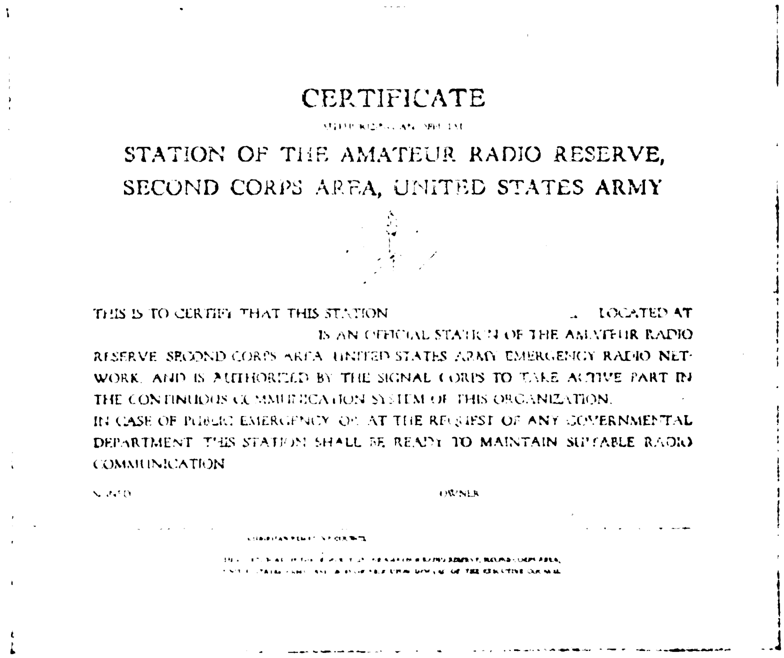
MAJOR GENERAL BULLARD HAS A WORD WITH THE AMATEUR RADIO RESERVE

One of the advantages of station WVP lies in the fact that the members of the Reserve can keep in direct touch with headquarters, not only for entertainment but for practical instructions in radio by the army's experts. Note the "soup-plate" transmitter and the wires leading from it to the transmitter.

"Here, we'll help you send those messages."

And it did.

A sort of Fiery Cross was established, not dissimilar to the Fiery Cross in the days of old Scotland. When that land was invaded, one clan sent word to another by means of a burning cross borne aloft by a runner; over vale and moor he rushed to the next clan. There the cross was snatched from his fainting hands and rushed on its way. So now the new carriers of the Fiery Cross went out with their message. The men were known, they were registered; from post to post flew the word, relayed on by one of the guards to another. It is now being so done; wireless operators, members of the Amateur Radio Reserve, pick up messages for the army and fling them across the country—carry them over vale and moor. Only they don't leave their homes. They merely press a key and the messages rush out into the night. How astonishing it would be to the runners bearing the flaming cross in the days of tempestuous Scotland if someone had told them that some day messages would be carried over the country without legs, without shouts, without wires! They would have thought something was the matter with the person and sped away faster than ever! But now it is actually being done each night. Between eight and ten o'clock in the evening this invisible army goes into action; it picks up government messages and sends them along—and not one cent of pay does a member get. It is all for the good of the cause; it is another way of carrying the Fiery Cross. A storm is raging; the telegraph lines are down; the government wants to send a message through the blizzard. The invisible army is there, for radio laughs at storm; the only thing that it is afraid of is static. It is more concerned with static



CERTIFICATE

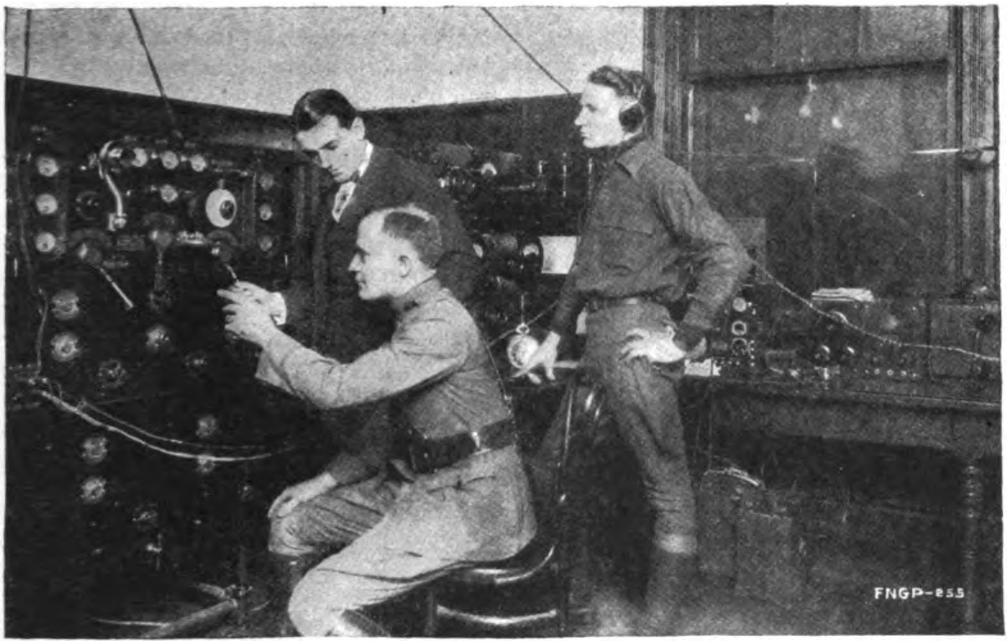
STATION OF THE AMATEUR RADIO RESERVE,
SECOND CORPS AREA, UNITED STATES ARMY

THIS IS TO CERTIFY THAT THIS STATION LOCATED AT IS AN OFFICIAL STATION OF THE AMATEUR RADIO RESERVE SECOND CORPS AREA UNITED STATES ARMY EMERGENCY RADIO NETWORK AND IS AUTHORIZED BY THE SIGNAL CORPS TO TAKE ACTIVE PART IN THE CONTINUOUS COMMUNICATION SYSTEM OF THIS ORGANIZATION.
IN CASE OF PUBLIC EMERGENCY OR AT THE REQUEST OF ANY GOVERNMENTAL DEPARTMENT THIS STATION SHALL BE READY TO MAINTAIN SUITABLE RADIO COMMUNICATION

SIGNED OWNER

THE AWARD OF MERIT TO THE AMATEUR

To become a member of the Amateur Radio Reserve, every candidate must conform to the requirements that cover his apparatus, his experience and his proficiency—and he must agree to relay messages at specified hours. Then (if his station is in the Second Corps Area, U. S. A.) he gets this diploma to hang in his radio room.



BEHIND THE SCENES OF A BROADCAST ENTERTAINMENT
When Richard Barthelmess, the film star, visited station WVP to give a talk as part of an Amateur Radio Reserve program, he visited the radio station—which is in a separate building of its own.

than an elephant is with a mouse, but a blizzard does not come with static in its hair, and so the lines of communication are kept open.

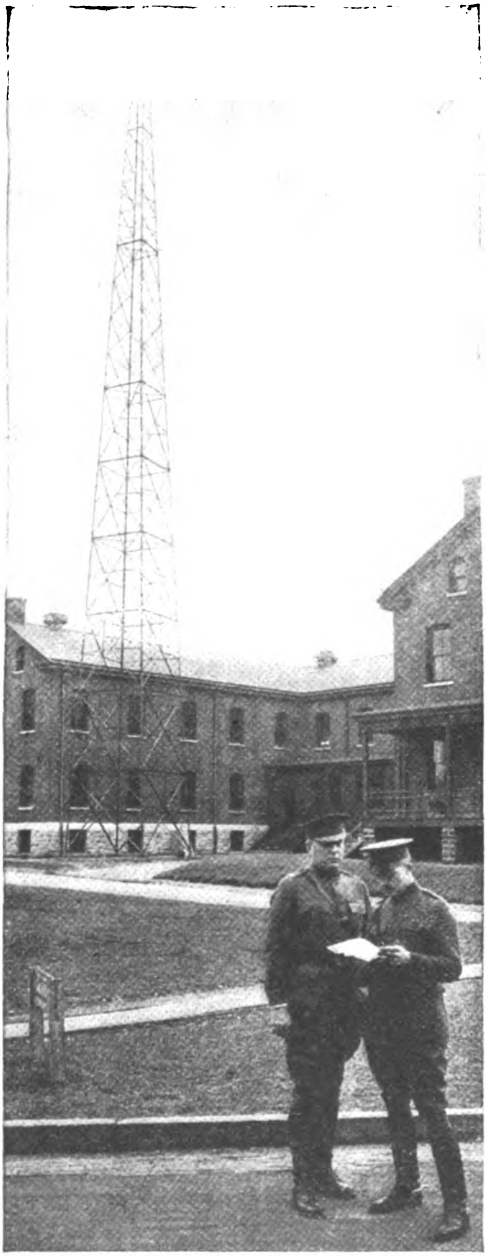
The Amateur Radio Reserve doesn't stop with its work of relaying government messages, helpful and patriotic as that is. That is only the beginning. The general public knows the Reserve through its broadcasting.

Six nights a week it takes over the broadcasting station WVP and sends joy and delight, entertainment and education, into the air. This high-powered station belongs to the Signal Corps of the United States Army, but for fifty-five minutes, six nights a week, it belongs to the Amateur Radio Reserve. The government doesn't chirp in with a word. It furnishes the equipment and the electricians for operating the station, but the Reserve is the big boss. Charles J. McBrearty is the master of ceremonies. You have heard his voice many times. You have heard this sentence over and over:

"This is the United States Signal Corps Radio Station, call letters WVP, at Fort Wood, Bedloe's Island, New York Harbor, transmitting on a wavelength of 1,450 meters. The first offering will be—"

McBrearty is the man behind the voice. Any night that you go out on the eight o'clock boat from the Battery and see a thick-set fellow with blue eyes industriously smoking a cigar, you may put him down as McBrearty. And when you get to the station and meet a dapper-looking lieutenant who looks as if he might be a whirlwind dancer—then that is Lieutenant Paddock. When you go in to broadcast you don't see anybody; you hear voices, shufflings of feet, mysterious sounds—and when you finish and look around the room is full.

The preliminary announcement as required by the Signal Corps is misleading. About one person in a hundred knows where Bedloe's Island is. As a matter of fact, it is the Statue of Liberty island.



From a photograph made for POPULAR RADIO

ONE OF THE ANTENNA TOWERS ON BEDLOE'S ISLAND

Through this station Uncle Sam keeps in touch with his public-spirited young radio amateurs who serve in the radio net in the Second Corps Area. This net includes about 20 stations, operated by about 80 members of the Reserve. These stations, beginning at New York City, are located at easy working distances up along the Hudson river valley and as far north as Plattsburg, on Lake Champlain.

The sending station is almost under the lady's left elbow. The only way to go back and forth is by boat—and pity on the poor wight who misses the last boat.

Singers, musicians, readers, poets, whistlers—they all come to WVP. In addition the Reserve sends out information and material of real help. It wants to be of service to its members, to make them expert radio men. So, for five minutes, five nights a week, the Reserve sends out instructions about radio. Arrangements have been made with POPULAR RADIO by which some of its helpful articles are sent out. "How to Select a Radio Telephone Receiving Set" was one; another was "How to Tune a Regenerative Receiver."

Unfortunately, however, announcement of this new feature was sent out in garbled form by a too zealous member. When it appeared in print it was to the effect that the Reserve would teach radio by mail. McBrearty almost had to put on a new stenographer. The letters flooded in. The Reserve teaches nothing by mail; all that it has to impart goes out by a faster method. The letters were amusing and pathetic. They go to show how eager people are to learn about radio. A boy from Honesdale, Pa., wrote in and said that he was anxious to get lessons by mail—and then closed: "My moral character is very good. I do not chew, smoke, swear or drink tea."

If mail lessons were to go out, certainly this model young man would be placed at the head of the list!

Curious and unexpected requests come to the Reserve. A telegram was received from the Rutherford (New Jersey) High School saying that it was planning to have a dance and that it could not get the orchestra it wished and could the Reserve put on a dance program for that night? The Reserve did; the dance was a success.

A request came from the people of Bronxville saying that a fair was to be held and could the Reserve supply some of the entertainment? The Reserve did.

Even so far away as Cuba the Reserve brings cheer and entertainment. One of the enthusiastic members is Frank H. Jones, who works for a sugar company at Tuinucu, in the heart of Cuba, and where there is no "great shakes" in the way of entertainment. Mr. Jones gives radio dances; he has a regular dance program card for the guests, even to the pencil tied on by a frazzled string; the card is filled out by the guests, the names written on the ruled lines—and then the little brown building under the Statue of Liberty tunes up and far away on the sugar plantation light-hearted merrymakers glide into each other's arms.

Many have the idea that since the Reserve broadcasting is done on 1,450 meters that a small receiving set will not suffice, but this is not true. Here is a letter that refutes this argument, from an amateur in Jersey City:

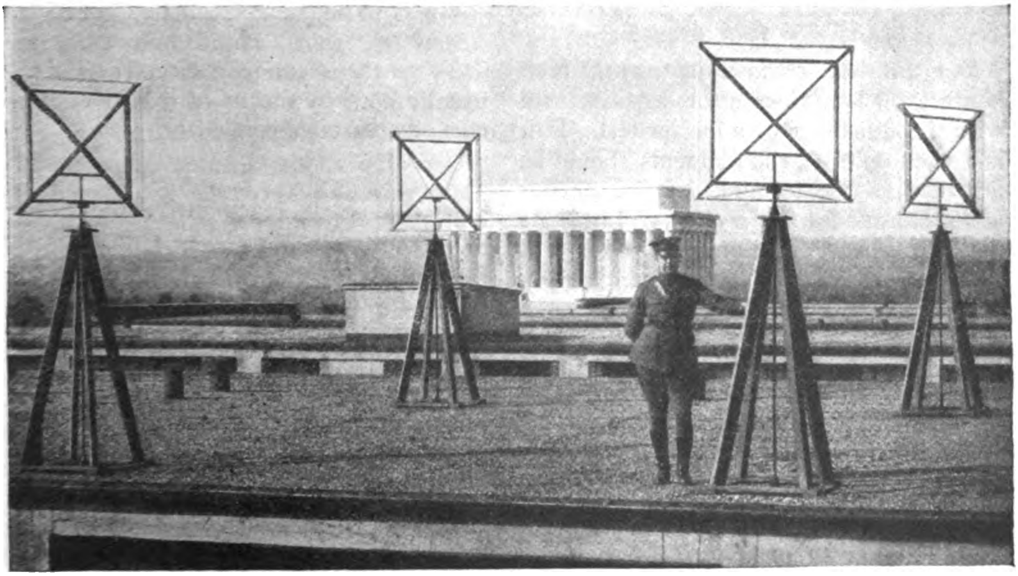
"I wish to let you know that I have only a small crystal set without any honeycomb attachment, and I can pick up WVP almost any time I wish to."

Members of the Amateur Radio Reserve are all of the better class radio enthusiasts. They are experienced men (there are no women) and must, according to the rules and regulations of the body, have had a year of radio. They pay a dollar a year dues, which doesn't begin to pay the expense. This the army contributes for the great help the members are giving in relaying messages. If a member wishes a "station certificate" he sends fifty cents additional; then he has something worth while to hang on his walls.

The members are all civilians, but if at any time war's black cloud should settle over the country, the members of the Amateur Radio Reserve will be given the the first opportunity to take up work in the Signal Corps—and the Signal Corps is becoming of constantly increasing importance in time of trouble. The little station certificate will then mean something.

Thus has it grown: nightly it relays messages for the government free of charge, and nightly furnishes entertainment and instruction for thousands, until now it is one of the real factors in the radio world.

And the baby was just a year old last June!



The first photograph of the army's permanent Radio Central in Washington, D. C. These loop antennae pick up signals that come from distances up to 6,000 miles.

Photograph by Bray Productions

20 TIPS ON TUNING—

That Every Radio Fan Can Use

1

SET the detector in adjustment. If it is a crystal type, locate the sensitive spot with the assistance of a buzzer test. If it is a vacuum tube, the filaments should be lit; then if one terminal of the phones is disconnected a sharp click will indicate that the tube is functioning.

2

TIGHTEN the coupling between the primary and secondary circuits by bringing the primary and secondary coils into closest inductive relation. (Not necessary in the single circuit type of receiver).

3

TUNE the antenna or primary circuit. This is done by taps on the inductance or by a variable condenser.

4

TUNE the secondary circuit. This is usually done by means of a grid variometer or a variable condenser.

5

IF the set is regenerative the tickler circuit should now be adjusted for maximum regeneration without distortion. In a honeycomb set this is done by moving the third coil (tickler coil) nearer to or farther away from the secondary circuit. Other regenerative circuits employ a variometer for this purpose.

6

IN the case of interference the coupling should be decreased and the signals tuned in again, in the primary and secondary circuits, until the interfering signal is eliminated. In a single circuit receiver the inductance of the antenna circuit should be varied and the signals retuned, with the antenna tuning condenser, until an adjustment is found where the interference is reduced to a minimum.

7

If your antenna length is too long (over 150 feet) put in a series variable condenser to bring down the wavelength to a suitable value.

8

If your antenna length is too short (under 75 feet) it would be advisable to put in either a variable condenser across the antenna inductance or a loading inductance in series with the antenna inductance to boost up the wavelength to a suitable value.

9

In a regenerative receiver it is advisable to regulate carefully the adjustment of the filament current; if the filament is high, less regeneration will be found necessary, and if the filament is reduced more regeneration will be required. One particular combination of these two adjustments will bring in the signals clearest and with least distortion.

10

There are three methods of varying the inductance of a coil: By means of taps, by means of a slider or by means of a continuously variable inductor such as a variometer.

11

Sharper tuning is accomplished by inductively coupled tuners than by conductively coupled tuners, and by two circuit receivers than by single circuit receivers.

12

Regeneration causes an effect similar to the elimination of resistance from the radio frequency circuits of a receiving set, and in this way does away with energy losses in these circuits, thus producing louder signals.

13

A vernier condenser (a variable with two or three plates) is a great help in tuning when it is connected across the secondary coil of a variocoupler in a regenerative circuit.

14

Distributed capacity in a tuning coil is deleterious to sharp tuning. Shellac or varnish or any form of wax adds to the distributed capacity of the coil to which it is applied.

15

The looser the coupling in a two circuit tuner the sharper will be the tuning.

16

A receiving set connected to a short, low antenna will tune sharper than if connected to a long, high antenna, although the latter will give stronger signals.

17

Tuning on a loop antenna is sharper than on an outdoor antenna; this is the case with all closed oscillatory circuits.

18

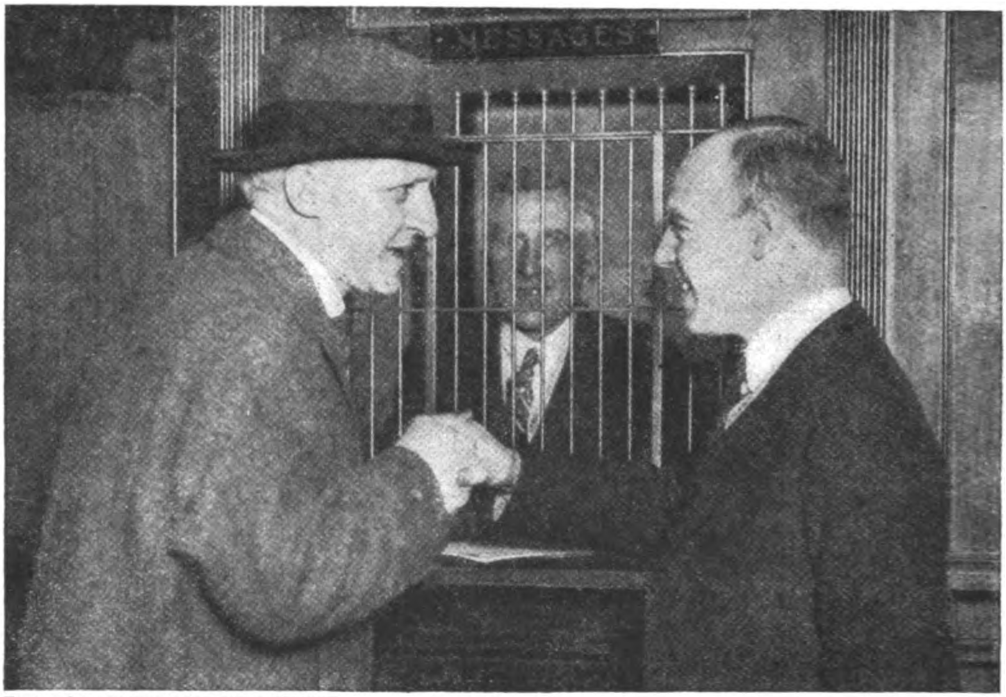
The less resistance in an oscillating circuit the sharper will be the tuning in that circuit.

19

The use of a smaller grid condenser in the vacuum tube detector circuit (say .00025 mfd. instead of the usual .0005 mfd.) results in greater selectivity of tuning.

20

At least 50 percent of the efficiency of a receiving set lies in the skill of the operator who is tuning it.



From a photograph made for POPULAR RADIO

I MEET WITH "INTERFERENCE" IN THE PURSUIT OF MY RADIO WORK

I had just taken a blank and started to write my message when I was greeted by an old friend—the traffic manager.

Orson Sends a Radiogram

Most folks still think that commercial radio messages are laboriously ticked out on the familiar telegraph key. But how they are really sent (as seen by a layman) is told here by the popular illustrator—

ORSON LOWELL

IT is still difficult to convince my numbed senses that what I saw actually took place. Of course, I knew in a taken-for-granted sort of way that radio communication between continents is carried on in regular commercial fashion, but this—

Why, this was so commercial that it was spooky! Imagine stepping from Broad Street, in the very heart of the financial district in New York, with nothing but this hazy conception of the sending and receiving of radio messages, into the room I shall here describe. There are six long tables; on one side of each table sit two men at typewriters working like mad, translating into messages a zigzag ink line on a paper tape that issues with astonishing speed from a little brass instrument. Across the table from these two men sits a third man at another typewriter-like machine which punches a curious series of dots into another paper tape. This tape he feeds into another little brass instrument, and a message is on its way to London or Berlin, or perhaps to a ship at sea. That's all there is to it, for each table is a duplicate of the others!

If this radio station had been located in a shack on some distant beach, if there had been a lone operator who pressed a telegraph key to the accompaniment of a great crashing electric spark, even if there had been a maze of complicated instruments, it would have been more convincing.

One might be inclined to lament that commercialized radio had lost some of the romance of early days—it is so matter-of-fact—were it not so utterly marvelous. When one can dictate a message on one side of a table and have the same message handed to him on a radiogram blank at the other side of the same table two minutes later with the calm statement that in that brief time your message had been to Europe and back, it's something to marvel at. That happened to me.

I might have gone through the rest of my life without suspecting that the things I "knew" about international communication were mostly wrong, if old Alex Anderson hadn't attended that fancy dress ball as Diogenes. To complete his costume I loaned him one of my prized possessions, a perfect specimen of an antique lantern. And it was just my luck two weeks later, when I received a commission for a painting to depict the development of lighting fixtures and needed that lantern for a model in the worst way, to discover that Alex had gone on a sudden business trip to London. I might have found another lantern for a model, but it wouldn't have been *my* lantern—you know how it is. So, for the sake of my own peace of mind, I decided to cable Alex and ask him where my lantern was.

At another time I might have passed 64 Broad Street with no more than a curious glance at the sign over the door, "Radiograms via RCA." But having decided to cable Alex, something prompted me to step in that morning and ask about rates to London. I expected to find radio rates outrageously high and then hunt the nearest Western Union office. Imagine my surprise, then, to find that I could send my message to London by radio at a saving of seven cents a word over cable rates. Further, the man at the window calmly assured me that I would get quicker service, because the message would go direct from that very building to the heart of London without being relayed.

So I took a radiogram blank and addressed Alex in London. I had just written:

"Where in the devil is my——"

Someone slapped me on the back and I looked up into the face of my old friend, W. A. Winterbottom.

"Speak of the devil and he's sure to appear," I said, and I showed W. A. the beginning of my message and explained.

"And," I said, "what are *you* doing here, anyway?"

I knew W. A. had been connected with wireless in some sort of way for twenty years or more.

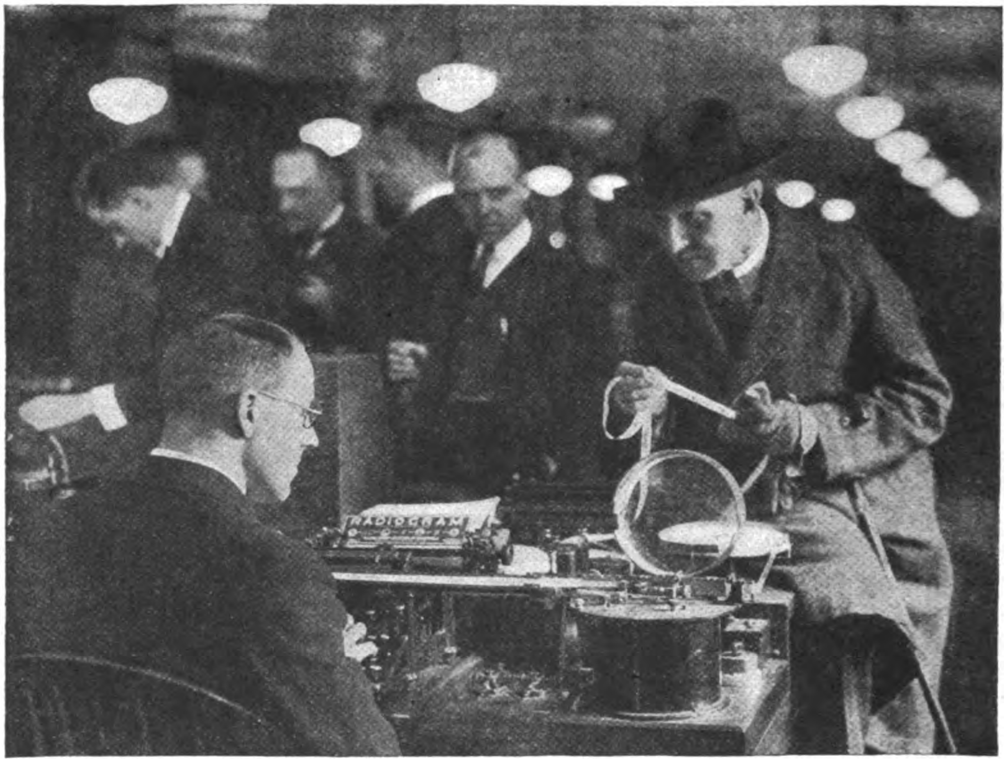
"I'm traffic manager for the Radio Corporation," he announced.

We talked over old times and the upshot of it all was that W. A. invited me to look over the plant. I was glad of the opportunity, for in the brief time I had been in the office I had conceived a great curiosity to know just how my message was going to get from that very building direct to the heart of London.

"Let your message go until we have finished," W. A. suggested.

So we passed through the outer office and into the forbidden regions above and beyond.

"The business," said W. A., "is growing so rapidly that this building will not hold us very much longer. You know I have been in radio twenty years and some remarkable progress has been made, but the really big things all have come within the past two years. Why, two years ago this office consisted of a little room downstairs and one small



From a photograph made for POPULAR RADIO

I LEARN HOW MY MESSAGE GOES TO EUROPE AND BACK IN A FEW SECONDS

The operator was translating into typewritten words the zigzag line on the paper tape which kept moving along a groove in front of the typewriter.

room upstairs, and that was all we needed to handle the radio traffic to and from this country. Since then we have been leasing more space, knocking out partitions and building additions to our plant almost constantly. In fact we aren't through yet and it now looks as if we would have to begin looking for larger quarters.

"This office now handles more radio traffic than any other in the world. All the world, it seems, wants to communicate with America, so this very office is the hub of radio communication for the whole world. As a matter of fact you can communicate from this office direct with Great Britain, France, Italy, Germany, Norway, Japan, and Hawaii, and we will soon have extensive connections with South America. In addition we can reach, through our connections, nearly all countries of Europe, Asia and Africa. And this is only a beginning. We plan to double and triple our facilities in the next few years."

"Good gracious," I said, "won't that take a lot of money? Who is going to put it up?"

"This company," said Winterbottom, "that is, the Radio Corporation of America. We are in partnership with the General Electric Company and the Westinghouse Electric and Manufacturing Company. You see, it's thoroughly American, and these firms are behind it with their capital and facilities. Our plans not only include telegraphic communication between America and all the world, but between South America and the rest of the world, and we will, no doubt, offer telephone service by radio, too, in the not distant future."

"But, man," I protested, "what's all this I have been reading about the radio telephone. Why haven't you adopted telephone service instead of telegraph already? I'd like to call up a friend of mine in London this very minute and pour a few confidential words into his ear."

"Of course," he said, "it is physically possible to do it, but there are several good reasons why we haven't, yet. The radio phones you have been hearing about are the numerous broadcasting stations that are sending out concerts and lectures for the entertainment of a couple of million new radio fans. The chief reason we use telegraph is because of the speed. We send and receive messages at the rate of a hundred words a minute, so that during the time a single telephone conversation would tie up our plant, we can send twenty or thirty messages. You can see that a radiophone message to Europe would be pretty expensive for that reason. Then there is the language barrier. That is the chief reason, I think, why telephonic communication will never be used on a world-wide scale. Aside from the difficulty of establishing connections through two centrals, each speaking a different language, only limited use could be made of such service because the subscribers could not understand each other. As it is now, most of our messages are sent in code. Our messages look like an unintelligible jumble of letters and even we do not know what they mean. But we transmit the message as it is given to us and when it is decoded at the other end, it is translated at the same time. So you see that telegraphic communication easily gets around the language barrier and it is possible for two firms to do business, neither understanding the language the other uses."

We had now entered the long operating or traffic room, which I have previously described. We stood at the back of the nearest operator, who was engaged in translating into code messages the zigzag line on the paper tape, which was kept moving across the front of his typewriter by a roller device. Apparently the speed of the tape was so gauged that the operator had to work at top speed to keep up with it.

"We send and receive more messages than any other station," said W. A. Each table you see represents a circuit for communication with a certain country. This first table is the British circuit, next is the German, and so on. You notice that it takes three men to handle the British circuit. I have seen the arrangements for handling the other end of this business in England and it takes just twelve Englishmen to do the work these three Americans are doing.

"We have got away from the old ticker key entirely. That was too slow, so we have developed these machines, which do the work two or three times as fast and more accurately than the best operators we have. It takes two operators to translate the messages that come in over one machine. We have designed and built these sending machines, too, and both are being copied all over the world. We are setting the pace in commercial radio just now, and several of the men you see in the room have been sent here by their governments to learn our methods. Come over and meet Mr. Wilfred Larsen of Naerboe, Norway."

I shook hands with Mr. Larsen and found him a most interesting chap. He is not so much a stranger in a strange land, he told me, for was he not in daily communication with the great radio station at Naerboe? And isn't it possible to get just as chummy by radio over the great stretch of the sea as any two railroad telegraphers could be over ten miles of wire?

I thought I had never seen a finer, cleaner looking bunch of fellows than the operators, and I said so to W. A.

"These men," he said, "are the pick of hundreds of applicants. A man must be a top-notcher to hold down a job in this room. We have three shifts a day and each shift works seven hours. And let me tell you, seven hours of this high-tension grind is a good day's work. There are no holidays, here, for the Fourth of July doesn't mean anything to the people at the other end of this system. Neither does any other of our national holidays. The only day in the year when our business lets up at all is Christmas. That's the nearest thing there is to a world-wide holiday. Another thing, our business doesn't stop at night. Remember that while we are in bed asleep, Japan is at mid-day and her business activities are in full swing. The same thing is more or less true of the other continents and that is an additional reason why the radio telephone cannot be used on a world-wide scale successfully. There is not even an appreciable slack in business here on Sunday. Even were Sunday observed faithfully over all the world, Saturday's business from one part would lap over into Monday's business from another part, for our communication with all parts is instantaneous."

From a photograph made for POPULAR RADIO

I SEE WHERE THE SIGNALS COME IN

On these tubes the messages from England, France and Germany are amplified—so my guide explained. It seemed plausible.

We had walked down the length of the room and into a smaller one at the end.

"And here," said my guide, "is where the signals come in. They are weak when they reach us, and so we have here a set of amplifying tubes very much like the ones used for listening to radio concerts. We bring the current up to the strength required to operate our machines with these."

He took a pair of ear-phones, pushed a plug into a hole, and held the 'phone to my ear. I heard a rapid, but regular succession of high pitched squeaks.

"That's the big station at Nauen, Germany, you hear," he said.

Then I listened to squeaks of a different pitch and different speed which, W. A. said, came from the big station at Bordeaux, built during the war by the A. E. F.; finally I listened to a big station at Towyn, Wales. All were tumbling messages into that office at break-neck speed.

"Well, W. A.," I said, "I have never seen anything quite so marvelous. Let's complete the job and go up on the roof to have a look at the aerial."

W. A. sort of exploded, buried his face in his handkerchief, and made funny noises for a full minute. Finally he could speak.

"Old man," he said, "your ignorance is refreshing. The only aerial we have on the roof is a very small one for test purposes only."

From a photograph made for POPULAR RADIO

I'M TOLD WHERE MY LOST PROPERTY IS—AT 18 CENTS A WORD

The radiogram had traveled across the Atlantic and back—only to inform me that my lantern was hanging before my eyes.

"Oh, I see," I said, "you don't need those things any more, either."

"Oh, yes, we do," he said; "do you really want to see the aerial?"

"I want to see the whole works," I said stoutly.

"What day can you go conveniently?" he said, drawing out a note book.

"What day?" I demanded, "Say, W. A., where is this aerial thing anyway?"

"It's about seventy miles from here, out on Long Island. But I advise you to go ahead and 'see the whole works.' There's not a sight like it anywhere else in the world. It'll take all day but it's worth it and I'll see that you are passed through and shown everything. What do you say?"

"I'm game. Make it Friday."

"Done!"

"But say," I said, "please enlighten me just a little bit now. How does it happen that the operators are here in New York and your aerial is seventy miles away out in Long Island?"

"Well, you see, in the old days when a radio station was both a receiving and a sending station, and the operator worked with a key and head set, he had to stop his sending machinery to receive a message and he could not receive while sending. We receive and send simultaneously here. That is done by sending our message by land wires to our sending station where it is relayed automatically and sent out from the aerial. The receiving station is about eighteen miles away from the sending station and the process is reversed there. That is, the message is received by an aerial, automatically transferred to land wires and carried to this room. We have a number of stations scattered up and down the Atlantic coast, all operated automatically from this room.

At the stations themselves there is only the machinery with men to tend it. There are no operators.

"The biggest of these stations—indeed the biggest station in the world is Radio Central, near Port Jefferson, Long Island. That's the place I want you to visit. I'll not tell you about it. You can see for yourself. But I promise you it will be a day well spent."

"Fine business, W. A.," I said, "now I've got to be getting along and I still have this radiogram to send to old Alex Anderson."

I sent the radiogram and it read:

"Where in the devil is my antique lantern?"

* * *

Not two hours later a messenger boy dressed in a neat brown uniform, but none the less all messenger boy, came to my studio with Alex's reply. It read:

"I returned your precious lantern it hangs on north wall of studio take a look.—Alex."

I took a look. And would you believe it, that darned lantern was hanging before my very eyes!

And Alex had sent the radiogram collect at eighteen cents a word.

In a following article Orson Lowell will give his layman's impressions of the amazing Radio Central Station on Long Island—where the huge equipment made him "feel like a pygmy in a giant's home."

International

THE GUMSHOE MAN GOES IN FOR RADIO

Here is just an ordinary rubber heel to which has been attached the parts of a practical little crystal receiving set. It was made by George E. Johnson of Minneapolis at a cost of $1.35. It receives over a radius of about fifteen miles.

From a photograph made for POPULAR RADIO

SOLVE YOUR EQUATIONS WITH A RULER AND A PENCIL

By merely laying your ruler across the alignment charts on pages 93 and 94 you may determine in an instant the problems in radio calculations that otherwise necessitate extensive computations—and do it more accurately.

MEASUREMENT CHARTS

FOR DETERMINING CONSTANTS OF RADIO CIRCUITS AND CALCULATING CAPACITIES OF CONDENSERS IN SERIES

By means of the "radio slide rule" originated by Mr. Hoffman, radio amateurs everywhere have been able to save a vast amount of time and at the same time insure accuracy in their calculations in the design of radio apparatus. The ingenious charts reproduced in this article constitute an equally valuable contribution to the science of radio; they were devised by the same inventor for the exclusive use of POPULAR RADIO.

By RAOUL J. HOFFMAN, A.M.E.

ONE of the most important problems to confront the amateur who designs his own radio set is how to calculate the correct sizes of the inductances and the condensers for the various parts of a radio circuit for a given wavelength.

There are several mathematical formulas for determining these "constants" as they are called. But these formulas are usually so complicated that they are not much used by the ordinary amateur.

Most amateurs who design their sets resort to the "cut and try" system; that is, they wind a temporary coil with taps, connect it in the circuit, find the correct tap and then build a permanent coil with a corresponding number of turns on it. Sometimes they build a number of coils and try them all out in order to find the best size to use.

Fairly good results are often obtained in this way, but this method is obviously unscientific. It entails a waste of time, energy and money. It is better and more practical to use standard formulas that will give the correct sizes for all parts to be built; further, these standard formulas enable the builder to design his set on paper and then build it according to the recorded specifications; in that way he will know in advance just what the results will be.

For the benefit of the average amateur, some of these standard formulas have been simplified and are represented here in the form of "alignment charts."

These charts offer the most convenient possible way of solving equations which have three or four variables. They make it possible for the ordinary radio fan to use the formulas without the aid of anything more than common sense and a ruler.

The prime problem to be dealt with in radio is that of "resonance" in the different circuits. In order to have resonance in a circuit, or in other words, in order to tune a circuit to any particular wavelength, the circuit must contain inductance in the form of a coil, and capacity in the form of a condenser. A certain value of inductance and a certain value of capacity together in a circuit give it a certain wavelength; unless either or both of these values are varied, the circuit will absorb energy of no other wavelength.

The basic formula for the wavelength (W.L.) follows the equation:

$$\text{W.L.} = 1884\sqrt{LXC} \ldots\ldots\ldots\ldots\ldots\ldots 1$$

wherein L is the inductance in microhenries and C the capacity in microfarads. The above formula is shown in chart form in Figure 2.

In order to illustrate the method of using this chart, let us take the following problem: In Figure 1 we have a coil connected in an antenna circuit. This circuit is equivalent to a coil with a condenser connected across it—the condenser in this case being the capacity between the antenna and ground.

The example is this:

To find the proper value of inductance for this coil when used in an antenna circuit that has a capacity of .0002 microfarads, in order to tune up to 400 meters. With a ruler on the chart in Figure 2, connect the value of capacity (.0002mfd.) on scale 1, with the wavelength desired (400 meters) on scale 2. The answer will be found at the intersection on scale 3; it is 225 microhenries.

This same example applies to calculations for a secondary circuit in which the capacity will be the variable condenser connected across the coil.

To calculate a circuit that has two capacities (as shown in Figure 4), we find first the resulting capacity which will follow the relation:

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \ldots\ldots\ldots\ldots\ldots\ldots 2$$

wherein c_1, c_2 are the capacities connected in series and c is the resulting capacity. This formula is plotted on a chart shown in Figure 3.

Let us take another example:

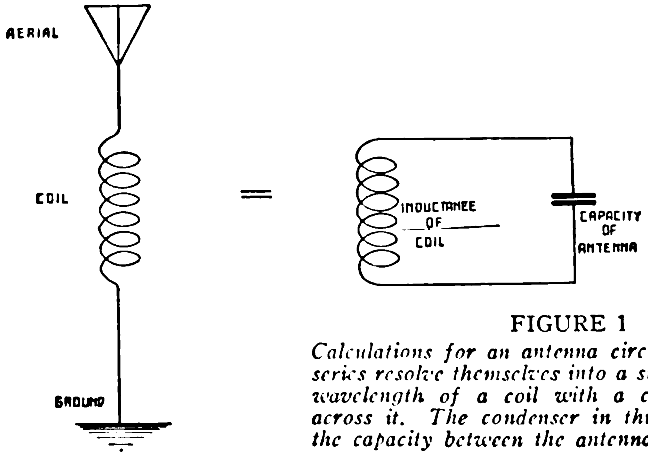
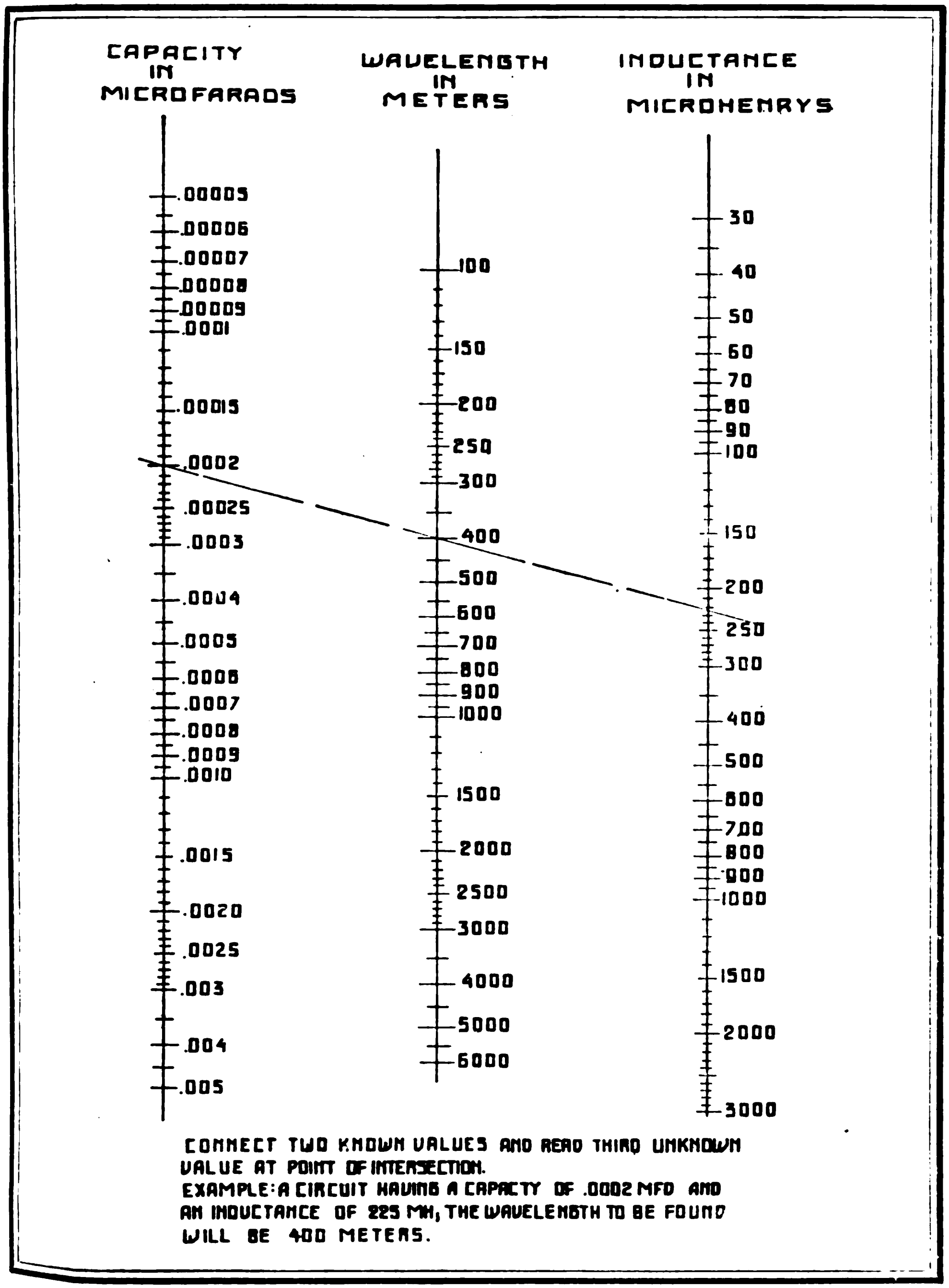


FIGURE 1

Calculations for an antenna circuit with a coil in series resolve themselves into a simple formula for wavelength of a coil with a condenser shunted across it. The condenser in this case represents the capacity between the antenna and the ground.

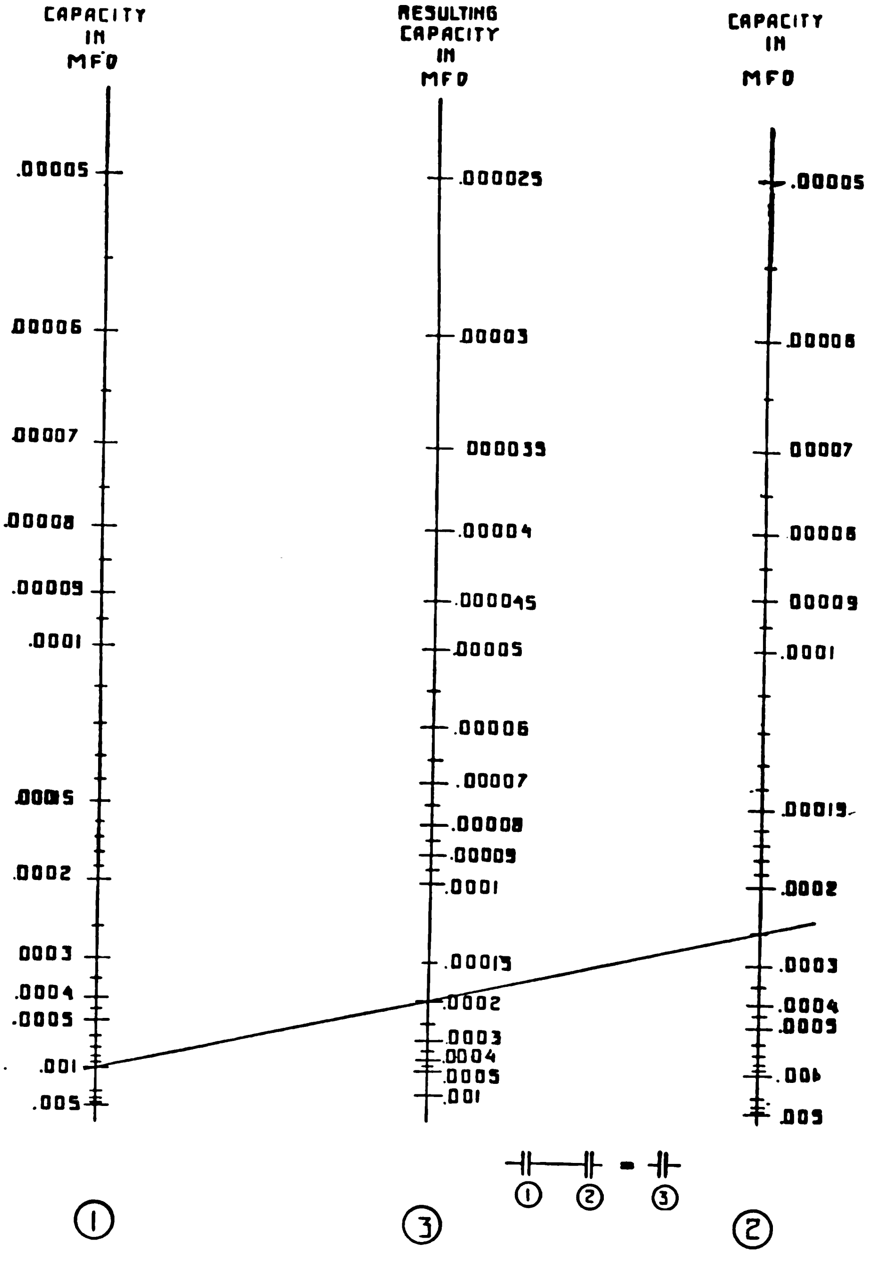


CONNECT TWO KNOWN VALUES AND READ THIRD UNKNOWN VALUE AT POINT OF INTERSECTION.

EXAMPLE: A CIRCUIT HAVING A CAPACITY OF .0002 MFD AND AN INDUCTANCE OF 225 MH, THE WAVELENGTH TO BE FOUND WILL BE 400 METERS.

A CHART FOR DETERMINING THE CONSTANTS FOR YOUR SET

FIGURE 2. *By merely laying his ruler across this chart (in the manner indicated by the diagonal line) the practical amateur may calculate the proper sizes for the condensers and the inductances of the set he proposes to build for use with a certain wavelength range. He need know little or no mathematics; the chart solves the difficult and intricate problems involved. The amateur has only to read from this chart the answer to his particular problem.*



A CHART FOR CALCULATING THE CAPACITY OF CONDENSERS IN SERIES

FIGURE 3. *The capacity of two condensers connected in parallel may be easily found by adding the capacities of each of the condensers together, which will give the capacity of the whole. But to determine the capacity of condensers in series is a more complicated matter. This chart indicates the answer to this problem; by laying a ruler across, as indicated by the diagonal line, calculations may be made.*

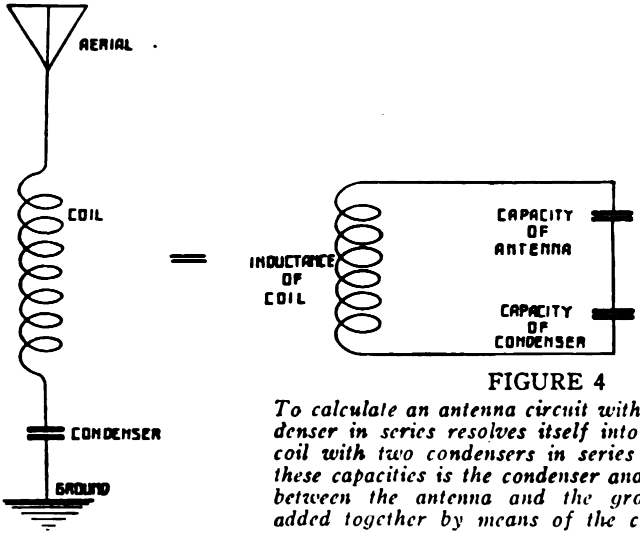


FIGURE 4

To calculate an antenna circuit with a coil and a condenser in series resolves itself into a formula for a coil with two condensers in series with it. One of these capacities is the condenser and the other is that between the antenna and the ground. These are added together by means of the chart in Figure 3.

Find the correct value of inductance to use in a circuit shown in Figure 3 in which a condenser is placed in series with the antenna circuit, the antenna having a capacity of .00025 mfd. and the condenser a capacity of .001 mfd. to tune to 400 meters.

The first step is to find the resulting capacity of the two condensers with the aid of the chart in Figure 3. Connect .001 on scale No. 1 with .0025 on scale No. 2 by a straight line and read at the intersection with scale No. 3 the resulting capacity of .0002 mfd. Having a capacity of .0002 mfd. and a desired wavelength of 400 meters, we find that we will need an inductance of 225 microhenries, as found in the first example we have given.

The chart shown in Figure 2 may also be used to find the wavelength, when the capacity and inductance are known, or to find the capacity when the inductance and wavelength are known. The general rule is this: Connect two known values on any two scales and the unknown will be found where the line crosses on the remaining scale.

The amateur is advised to keep these charts for reference, to be used along with additional charts on the design of coils necessary to get a certain value of inductance, and also with charts that will calculate the capacity of an antenna.

By the use of these charts the amateur may design his set with a definite knowledge of what wavelength range to expect when his set is finally put together and connected up.

Simple Coil Calculations for Amateurs

Mr. Raoul J. Hoffman—the author of the above article and the creator of many valuable time-saving charts and formulas—has prepared another article that will prove invaluable to the man who builds his own coils and who must know specifically how to determine (1), the dimensions for the diameter; (2), the length; (3), the number of turns; and (4), the size of the wire he should use. In Popular Radio—for March.

From a photograph made for POPULAR RADIO

The author—who is pictured above in his electrical laboratory at Cornell University—is an associate of Prof. Vladimir Karapetoff, whose remarkable experiments with inductances and antenna formulas have established him as an authority among radio amateurs everywhere.

Shall I Use A "HARD" OR "SOFT" TUBE?

Should the amateur discard the temperamental soft tube as a detector and select instead the slightly less sensitive hard tube that has greater stability? The answer to this disputed question is pointed out in this article by—

WILLIAM C. BALLARD, JR.

THE directions that accompany most vacuum-tube receivers advise the user to employ a "soft" tube as detector and "hard" tubes as amplifiers. But after the tubes have been obtained the only apparent difference between them, in most cases, is in the label on the base of the tube. That is because the only actual difference between a hard and a soft tube is in the amount of gas that is left inside the tube when it is sealed off.

The term "soft" as applied to a vacuum tube is something of a puzzler to most people, as there is nothing about any kind of a vacuum tube that would suggest such a name. The name, however, has been handed down from "X-Ray" terminology and indicates a tube through which a discharge can be easily produced and whose rays have but feeble penetrative power. When these tubes are investigated it is found that they do not have a very high vacuum and contain appreciable traces of some gas or gases. If the traces of gas are removed from the "X-Ray" tube either by absorption or pumping, the tube becomes "hard" and requires a much higher voltage for its operation as a consequence. The rays sent off by a hard tube have much greater penetrative power and are frequently spoken of as "hard" rays.

In order to understand just why a trace of gas makes a tube a good detector we will have to consider briefly what goes on in the detector circuit.

Figure 1 shows a common connection used for detector tubes. The radio signal sets up an alternating current in the antenna circuit almost exactly similar to the kind of alternating current we use for electric lights and power, but one which changes its direction about ten thousand times as rapidly as the kind we use for such purposes. An alternating current is one that flows for a while in one direction, stops, and flows for the same time in the opposite direction; then it reverses and flows in the original direction again, and so on indefinitely. The alternating currents with which we have to deal in radio reverse their direction of flow very rapidly. For instance, if we are receiving a 300 meter wave the current never flows in any given direction for over one-half of one millionth of a second. The usual way by which the rapidity in which a current builds up and dies down is measured is in "cycles per second." When the current has built up in one direction, reduced to zero, built up in the other direction, reduced to zero and come back to its original starting point, we say that it has gone through one "cycle." Applying this form of measurement to the 300 meter wave mentioned above, it requires one millionth of a second to complete a cycle. Hence the frequency is recorded as one million cycles per second.

If we were able to put a current of this character through the windings of a telephone receiver there would be little or no effect produced. While the current is flowing in one direction it tries to pull the diaphragm or vibrating metal plate toward the magnet, and when the current has reversed the opposite force will be exerted on the diaphragm. But for the 300 meter wave these opposing pulls will only last for one-half of one millionth of a second apiece, and before the first pull has any chance to move the diaphragm the second pull acts on the diaphragm and neutralizes the effect of the first pull. Since the push and pull are equally strong there will be no appreciable motion of the diaphragm.

But we can make these currents actuate a telephone receiver if we can make the pulls stronger than the pushes or *vice versa*. Under these conditions the effect of one pull cannot be exactly balanced out by the next push, and after several strong pulls and weak pushes the diaphragm will begin to move. As the diaphragm moves it pushes a little air along in front of it and thus produces a sound wave.

From the way in which the process has been described the reader may think that the diaphragm is moving slowly, but actually it moves so rapidly that your eye cannot begin to follow it. But as rapidly as it is moving, its motion is slow compared to the lightning-like changes of the radio current, and we may have several hundred pushes and pulls before there is any appreciable motion of the diaphragm.

One way to make the pulls stronger than the pushes would be to entirely eliminate the pushes, or more strictly speaking, the electric currents that produce the pushes. This is just what happens when we use a crystal detector. The crystal has the property of letting currents pass through easily in one direction and of shutting them out almost entirely in the other direction.

The vacuum tube accomplishes this result not by shutting off all current in one direction but by making the pushes and pulls of unequal force. Referring to Figure 1 again, the radio waves set up currents in the antenna circuit and their effect is in turn transmitted over on to the grid of the detector tube. These alternating currents in the antenna circuit produce alternating voltages on the grid, which may be considered in the light of electric pushes and pulls following each other rapidly. The telephone receivers shown in the diagram are not connected directly in the grid circuit but are placed in a second circuit known as the "plate circuit" on account of the fact that in order to complete the circuit, current has to flow between the filament and the plate. The peculiar action of the vacuum tube lies in the control which the grid has upon the current flowing in the plate circuit. The grid acts as a sort of screen through which the plate current has to pass in its passage from the filament to the plate and the amount of current that gets through the screening grid depends upon the voltage applied to the grid at that particular instant. If the grid is positively charged, by connecting the positive side of a battery to it and the negative side to the filament, the plate current will increase to a value higher than the value which would flow when the grid is connected directly to the filament by a piece of wire. When the connections to the battery are reversed so that the negative pole is connected to the grid and the positive pole is connected to the filament, the plate current will drop to a still lower value.

The simplest way in which to express a complex relation such as exists between plate current and grid voltage is in the form of a "curve." To show the relation between plate current and grid voltage we rule a number of equi-distant parallel lines, both vertical and horizontal, and assume that distances measured in a horizontal direction to the right represent *positive* grid voltages, horizontal distances measured to the left represent *negative* grid voltages, vertical distances measured upward represent *positive* plate currents and vertical distances measured downward represent *negative* plate currents. The heavy horizontal and vertical lines represent the lines from which we start the measurements. In order to find out just what current will flow when the grid is one volt negative we look for the first vertical line to the left of the heavy vertical line and follow this line up until it crosses the curve. The distance that we had to travel along the first left-hand line to reach the curve will give us the value of the plate current under the specified condition of one volt negative on the grid, and this length can be most easily

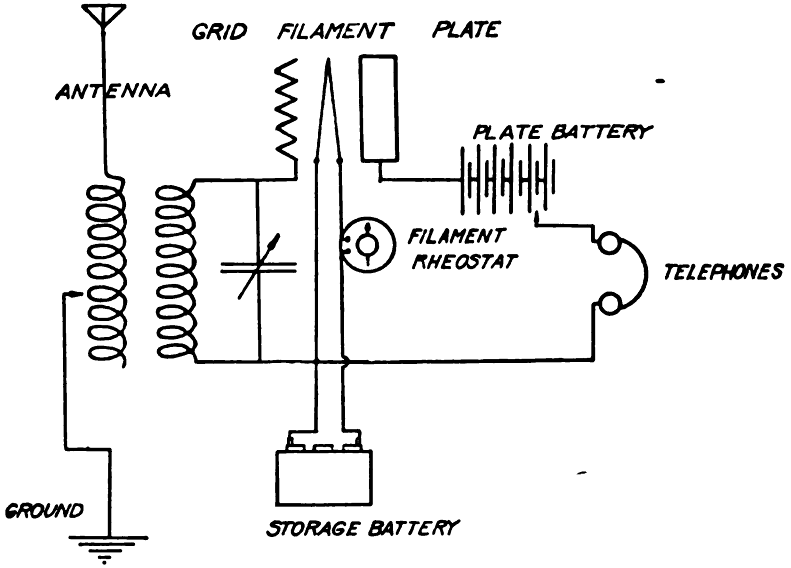


FIGURE 1
A vacuum tube used as a detector is shown in this diagram. To simplify the explanation of the functioning of the circuits, the grid condenser, which is used in most cases, has been omitted.

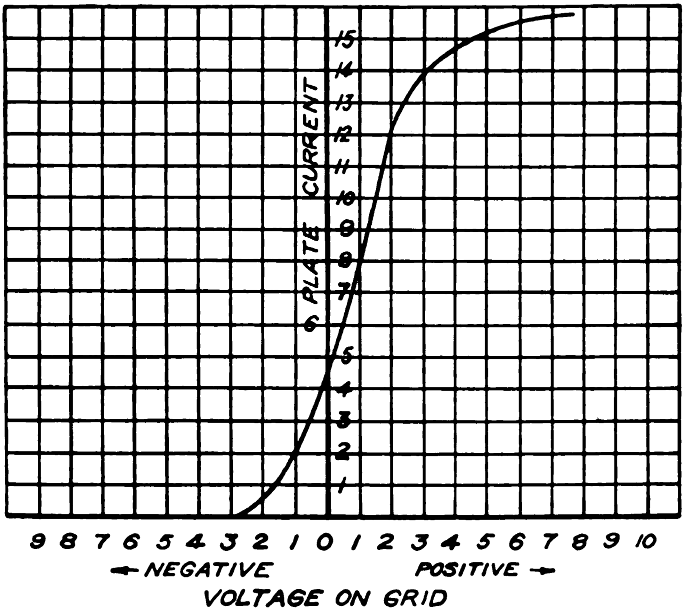


FIGURE 2

The relation of grid voltage to plate current in a hard tube is shown by what is known as the "characteristic curve."

found by projecting it over by eye on the heavy vertical line where the scale of units of plate current is shown. In the case shown the plate current is 2.

If we investigate the value of plate current when the grid voltage is one volt positive we will have to follow the first right-hand line up until it intersects with the curve and the corresponding value of plate current in this case is 8. Similarly, when the grid voltage is zero the plate current has a value of 4.5.

For the sake of simplicity, let us suppose that the value of the grid voltage induced from the radio signal varies between one volt positive and one volt negative, the plate current will increase up to 8 when the grid is positive, drop back to 4.5 when the grid voltage is zero and drop still further to 2 when the grid is one volt negative. The plate current passes through the telephones and when the plate current is increased beyond its normal value the pull on the diaphragm will be increased, producing a "pull" on the diaphragm. When the grid is negative the plate current will drop below its normal value, and by cutting down the pull below normal give the diaphragm a push in effect. On account of the curved shape of the curve, the pull will be stronger than the corresponding push so that the diaphragm will finally move after several cycles have acted upon it, and thus send out a sound wave. If the "curve" had been a straight oblique line, the value of the pull and the push would have been more nearly identical and a lesser effect would have been produced upon the telephone diaphragm. On the other hand, if the curve had been very much more curved or had a sharp break in it, the difference between push and pull would have been much more marked and the pull on the diaphragm would have been even more pronounced with a consequently stronger signal.

The curve shown in Figure 2 was drawn for a hard tube. The high vacuum and the absence of all gas gives a smooth curve and one which usually does not have any very sharp bends in it. Where slight traces of gas are left in the tube the curve is more likely to resemble that shown in Figure 3. From an inspection of this curve it can readily be seen that

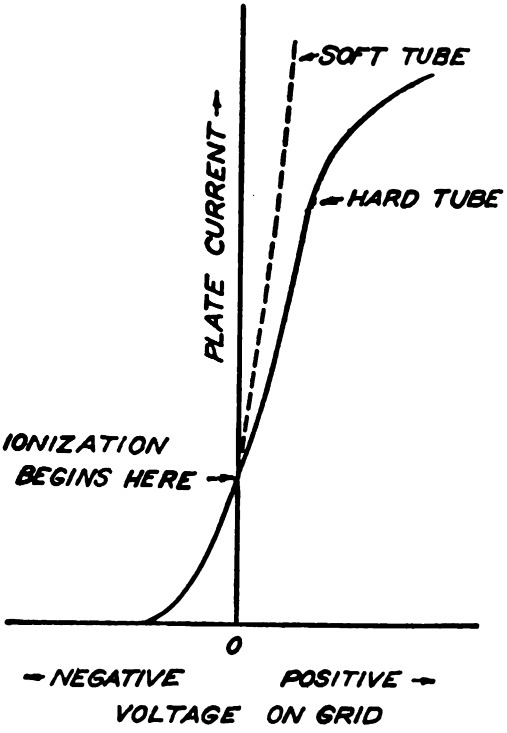


FIGURE 3

The characteristic curves of hard and soft tubes are here compared. Note how the plate current is increased in the soft tube by "ionization."

there will be a large difference between the corresponding pushes and pulls and a correspondingly strong signal in the telephones. The reason for this sudden break in the curve is due to the effects of "ionization by collision."

As the electrons sent off by the filament in a soft tube are drawn over to the plate they collide with some of the gas particles or molecules still left inside the tube. Up to a certain electron speed nothing happens, but when the electron is moving rapidly enough it will break up any gas molecule with which it comes into contact. The gas molecule is composed of a small particle of gas to which are attached small particles of electricity. When the gas molecule is broken up, some of the electricity is set free and moves over with the other electrons to the plate, thus increasing the plate current. This value of speed necessary to break up the gas molecule is quite well defined and the plate current takes a sudden jump just as soon as it is reached. When this ionization action is very intense it causes a blue glow inside the tube. The best adjustment for detector action is very much below the blue glow point and can be best determined by listening in the telephones while gradually increasing the plate voltage and filament current. When a certain point has been reached a hissing and frying sound will be heard in the telephones; this indicates that the first stages of ionization have been reached. Now turn the plate voltage or filament current down until the hissing has just disappeared and the tube should operate at its best point.

There is one difficulty in the operation of soft tubes; they are liable to change their degree of "softness." The metal parts inside the tube have the property of absorbing and giving up gas, depending on what happens to be going on inside the tube. In general, heating either the electrodes inside the tube or the glass walls of the tube will set gas free into the tube. On the other hand, operating a tube at or near the blue glow point has a tendency to absorb some of the free gas and make the tube harder. Tubes usually grow harder in use rather than softer, so that it is sometimes possible to bring them back to their original sensitive condition by carefully heating the glass bulb. The heating of the bulb has the tendency of loosening up some of the gas particles that have become stuck on the sides of the bulb, thus reducing the vacuum to the proper sensitive point.

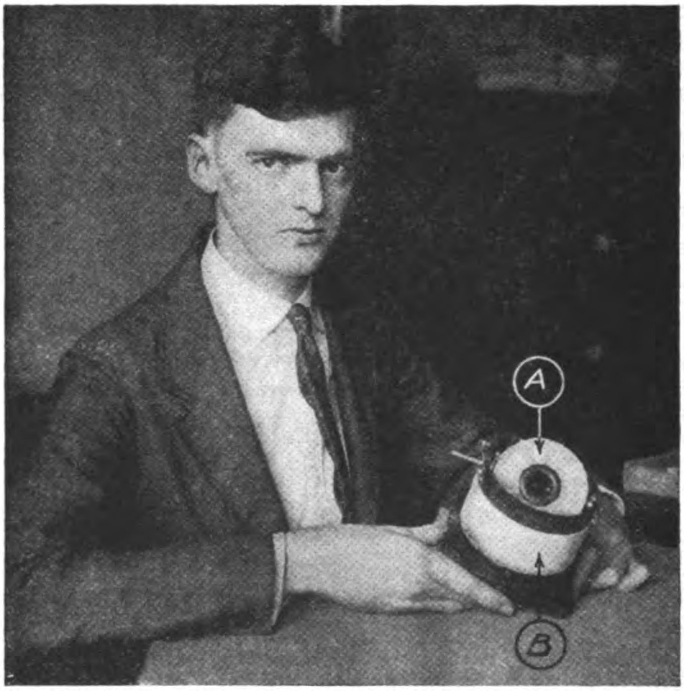
There is a comparatively simple test which almost any experimenter can make to determine the degree of vacuum inside a soft tube. This test requires a small spark coil which can give about a one-quarter inch spark. Connect one of the high tension terminals to the battery (if not already so connected) and set the coil into operation. Next, grasp the tube in the hand, taking hold of the glass bulb, and take care that no part of the hand comes nearer than an inch to the metallic base. Touch any of the terminals to the high tension lead of the spark coil and carefully examine the tube for any signs of glow inside it. No glow at all indicates that the tube is either very hard or else that it is full of air. A pale greenish glow which seems to stick on the inside surface of the glass bulb indicates about the right amount of gas for good detector action. It may operate all right when the bulb fills with a pale greenish-blue glow, but if the glow is purple or confined to a small area directly around the plate and filament the probabilities are that there is too much gas inside the tube to give satisfactory detector action because of excessive ionization.

Soft tubes, while undoubtedly more sensitive as detectors, are not particularly reliable and for this reason many experimenters are using hard tubes as detectors and making up the difference in signal by using more amplification. This is particularly true with a regenerative receiver, where the detector circuit losses are eliminated by the feedback action of this circuit.

Kadel and Herbert

A LITTLE EVE DOES A LITTLE EAVESDROPPING

With a miniature radio receiver consisting of a tiny coil and a crystal detector, and with one wire attached to a lamp post as an aerial and another wire attached to an iron window grating as a ground, this young lady, Miss Ellen Hopkins of New York, is finding out what her elders are talking about in the ether. In satisfying such curiosity she differs not at all from several hundred thousand little Adams listening in with their receiving sets throughout the land.



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A VARIOCOUPLER WITH ZERO COUPLING

In this hybrid device the inventor—pictured above—has combined the secondary coil of the spider web tuner (B) with the primary coil of the cylindrical tuner (A).

A NOVEL TUNER FOR

Shutting Out Interference

By S. R. WINTERS

FROM the viewpoint of the practical interests of the novice or amateur in the radio game, selective tuning in the variable coupler is a matter of the greatest moment; the more nearly zero the capacity coupling, the greater the practical value of the coupler in producing selective tuning.

In the Bureau of Engineering of the United States Navy Department there is a radio engineer—Alfred Crossley by name—who has rebelled against the conventional way of designing and building the receiving transformer or coupling arrangement. His creative effort has recently contributed to the radio science a variocoupler of novel conception, for which he claims the ability to achieve absolute zero coupling—an accomplishment not heretofore credited to any variable coupling device.

The coupling arrangement used between primary and secondary radio circuits is generally known as a "tuner." However, it is handed across the counter in radio stores under various designations, "variocoupler," "loose coupler," "honeycomb coils," "lattice-wound coils," "stagger-woven coils," "basket-wound coils," "tuning coil" and "duo-lateral coils."

These various coupling devices have much in common in structural details. The primary coil ordinarily consists of approximately fifty turns of wire, tapped at each five or ten turns. The secondary coil or circuit contains from thirty to fifty turns of wire, the shape of the latter almost invariably being cylindrical. In addition to the inductive functions of these tuners the primary coil forms one plate of a condenser while the secondary circuit functions as the other plate. This is a detriment to good tuning.

In breaking away from this beaten path Mr. Crossley attacked the problem fundamentally from the standpoint of obtaining a high maximum and low minimum inductance in the coupler, and at the same time a minimum amount of electrostatic capacity.

There are two electrical constants found in a radio circuit—an electromagnetic field and an electrostatic field. Dr. Charles P. Steinmetz, the master electrical genius of the General Electric Company, in disclaiming the existence of ether waves, asserts "that the magnetic and electrostatic fields are usually combined, since where there is a current producing a magnetic field, there is also a voltage producing an electrostatic field." Thus the space surrounding a wire that carries an electric current is disturbed by the combination of a magnetic field and an electrostatic field. Static or frictional electricity—the kind that is produced when a strip of hard rubber is rubbed against a cat's fur, to cite an interesting instance—is a detriment to tuning between radio circuits and it is desirable to reduce it to a minimum value in a tuning instrument.

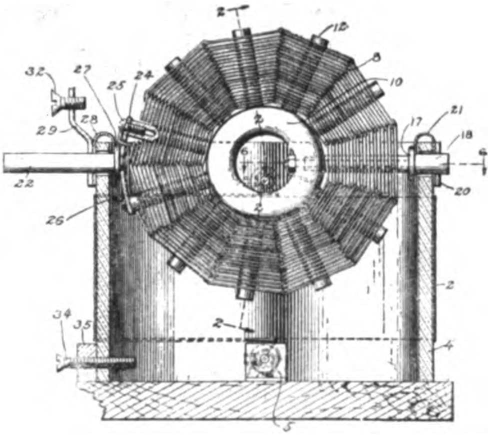


FIGURE 1

The tubular coil is cut away in this diagram to show more clearly the details of the secondary coil.

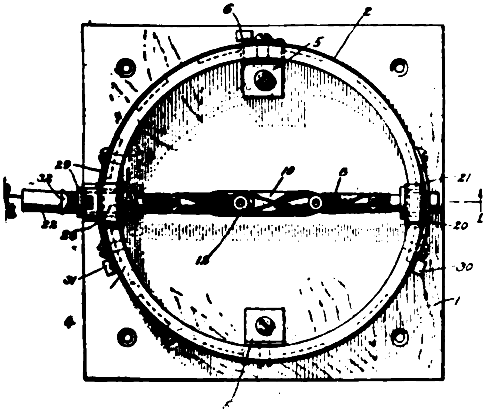


FIGURE 2

In this plan view the rotor is shown in the position of minimum coupling.

The efforts in previous designs of "loose" or variocouplers to retain a wide range of inductance and at the same time reduce the electrostatic capacity to a minimum have not as yet met with complete success. Professor L. A. Hazeltine of the Stevens Institute of Technology made a stubborn effort to "kill" the capacity effect between the primary and secondary circuits by substituting grounded windings over the latter circuit. Zero capacity coupling was not fully attained and the plan was abandoned.

Mr. Crossley, in his design of variable coupling, discards the cylindrical form common to prevailing types of secondary coils and substitutes a spider-web rotor. The latter contains a hard rubber hub, with tiny hard rubber spokes radiating from the center. Interwoven in these spokes are the windings of the secondary coil. Approximately forty turns of wire are used in this spider-web rotor. In operation, maximum transfer of electric energy from the antenna circuit to the secondary circuit is effected when the plane of this spider-web winding is at right angles to the axis of the primary winding. On the other hand, minimum or zero coupling is obtained when the plane of the secondary winding is approximately in line with the axis of the coil or wire constituting the primary circuit.

The winding on the rotor of this newly designed variocoupler is similar in design to the intricate webs fashioned by a spider; hence the designation, spider-web variocoupler. The instrument may be employed in a variety of radio frequency circuits. It is especially applicable for use in radio frequency amplification, a form of radio telephone reception that is becoming increasingly popular in a nation-wide broadcasting service.

This adaptation of the Crossley coupler is established by virtue of the ability of the coupler to reduce to a negligible quantity the passage of electrostatic energy from the antenna to the input circuit of the radio frequency amplifier. The device not only successfully prevents electrostatic coupling, a redeeming feature in itself, but further qualifies its claims to superiority as a coupling arrangement by imparting a maximum electromagnetic coupling. When used in the tuning circuit before a radio frequency amplifier the stator or primary winding is connected in the antenna system proper, and the rotor or secondary winding is connected to the input circuit of the initial stage of radio frequency amplification.

If employed in Major Edwin H. Armstrong's regenerative or super-regenerative circuits, the stator may be connected in the grid circuit with the rotor in the plate circuit, forming the feed-back coupling.

The electrostatic capacity, at minimum coupling between the primary and secondary windings of this new variocoupler, is less than one micro-microfarad. At maximum coupling, the electrostatic capacity between the two windings is five micro-microfarads.

In actual test at Washington when NOF, the Naval Air Station at Anacostia, with an antenna current of thirteen to seventeen amperes, was transmitting, both the primary and secondary circuits, employing this design of receiving transformer, were adjusted to the wavelength of 412 meters. By obtaining zero coupling, this high-power radio telephone broadcasting station was tuned out completely. However, by merely moving the rotor of the coupler one degree or fractional part to the right or left of zero coupling, Anacostia was retuned in vigorous fashion; or, at will, NOF could be tuned out and Pittsburgh, Newark, Schenectady or other far-distant broadcasting stations could be "copied" even while Anacostia continued its high-power broadcasting service.

The selectivity of this tuning device, if we are to accept the claims made and results accomplished in preliminary tests, should be a boon for the reception of radio signals on bands of wavelengths closely approximating each other.

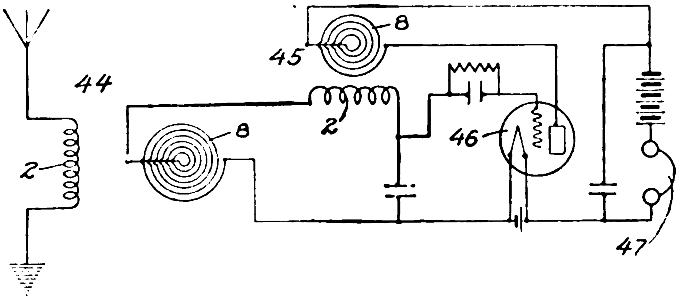


FIGURE 3.

An interesting use may be made of two of these couplers, one as a tuner and the other as a feedback, as shown in this diagram of a regenerative circuit.

From a photograph made for POPULAR RADIO

¶ *Every radio fan is familiar with the little black box into which weak signals enter and out of which they come forth strengthened. If you want to know just how the tubes and transformers within the amplifier work together to create this phenomenon, read—*

HOW THE

Audio Frequency Amplifier Works

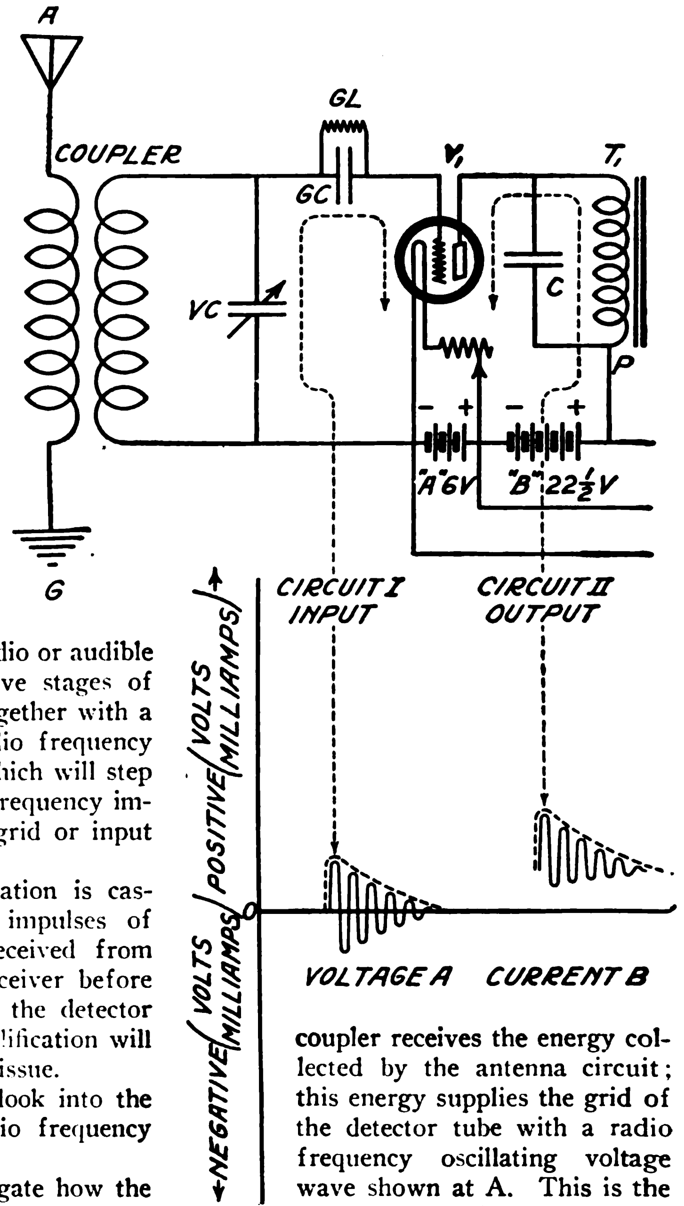
SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 8

By LAURENCE M. COCKADAY, R.E.

THE problem of vacuum tube amplification is somewhat different from that of vacuum tube detection, although the same essential theory of operation of the tube is observed.

The vacuum tube is a potentially operated (voltage controlled) device, as explained in the December issue of this magazine. This same principle is used for amplification.

Dr. Lee De Forest saw the feasibility of using the amplifying qualities of the vacuum tube when he took out his patents on the "cascade amplifier," as he called it. This system uses a number of vacuum tubes connected in cascade, coupled together by means of transformers so that the output circuit of the detector tube is connected to the input circuit of the first amplifier tube, and so on with the second and third amplifier tubes. It is not good practice to use more than three or four stages of this type of amplification, on account of "tube noises" which are amplified along with the signals and which tend to blur the clarity of reception.



This "cascade amplification" may be divided into two classes:

First, audio frequency amplification.

Second, radio frequency amplification.

Audio frequency amplification is cascade amplification of the rectified impulses which are flowing in the plate circuit of the detector tube. These impulses are of an audio or audible frequency and the successive stages of amplification are coupled together with a transformer called an "audio frequency amplifying transformer," which will step up the voltage of an audio frequency impulse and supply it to the grid or input circuit of the next tube.

Radio frequency amplification is cascade amplification of the impulses of radio frequency current received from the antenna circuit of a receiver before they have been rectified by the detector tube. Radio frequency amplification will be taken up in a following issue.

For the present we will look into the inner workings of the audio frequency amplifier.

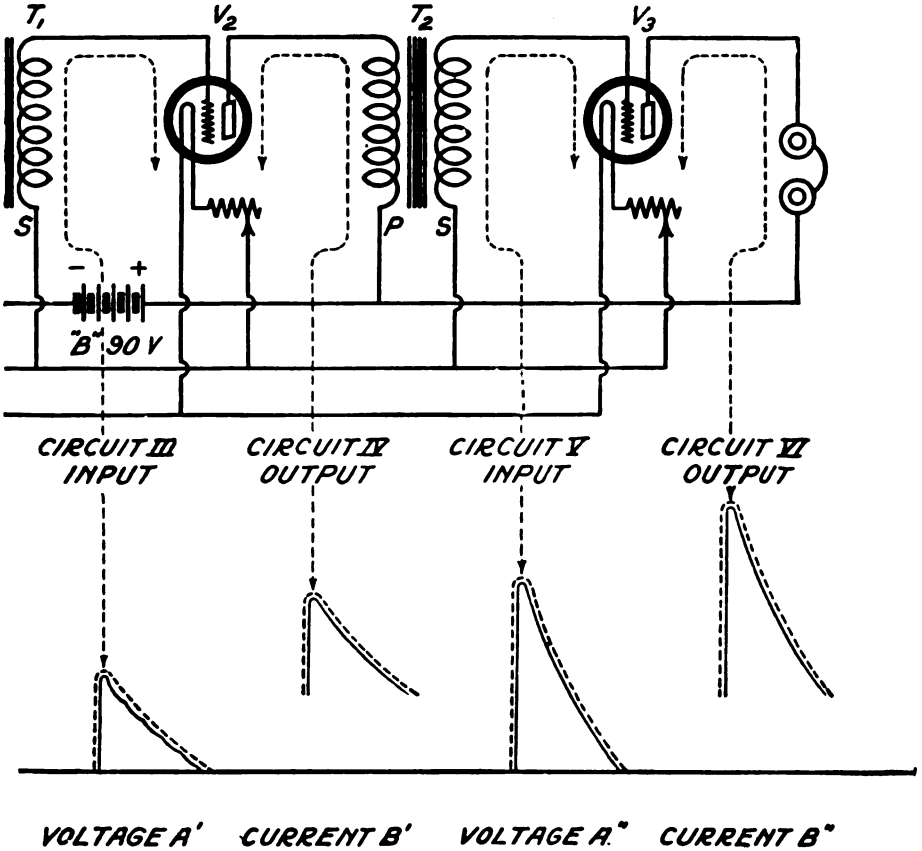
First of all, let us investigate how the series of tubes used in this method are connected.

In Figure 1 we have a standard hookup for an inductively coupled tuner with a vacuum tube detector; added to this is a two-stage audio frequency amplifier. The first stage consists of a transformer, T^1, and a vacuum tube, V^2; the second stage likewise contains similar instruments, T^2 and V^3.

The secondary circuit of the receiving coupler receives the energy collected by the antenna circuit; this energy supplies the grid of the detector tube with a radio frequency oscillating voltage wave shown at A. This is the voltage across the circuit designated as Circuit 1.

The tube V^1 then acts as a relay and produces an amplified impulse in its plate circuit (Circuit 2), which has the same audio frequency wave form as the original impulses in Circuit 1. These wave forms can be compared by referring to the dotted lines in curves A and B. The radio frequency component of the current B is passed around the transformer

FIGURE 1. *This circuit diagram and chart shows how the successive stages of amplification increase the minute voltages and currents of a received signal until they are strong enough to operate a loudspeaker, thus producing a signal which can be heard throughout the entire house.*



winding P by means of the bypass condenser C, and only the audio frequency component of the current B (which is shown by the dotted lines) passes through the winding P. This current, flowing through P, induces a similar impulse in the secondary winding S, except that the voltage of the impulse induced across the Circuit 3 is higher than the voltage in Circuit 2 on account of the step-up ratio used in the transformer windings.

The voltage in Circuit 3 is shown at A^1. By comparing the voltages A and A^1 we readily see that in A^1 we have a much greater voltage impressed on tube V^2 than the A impressed on V^1. Therefore in the plate circuit of V^2 (Circuit 4) we have a greater current response than in V^1, Circuit 2. Compare the currents B and B^1.

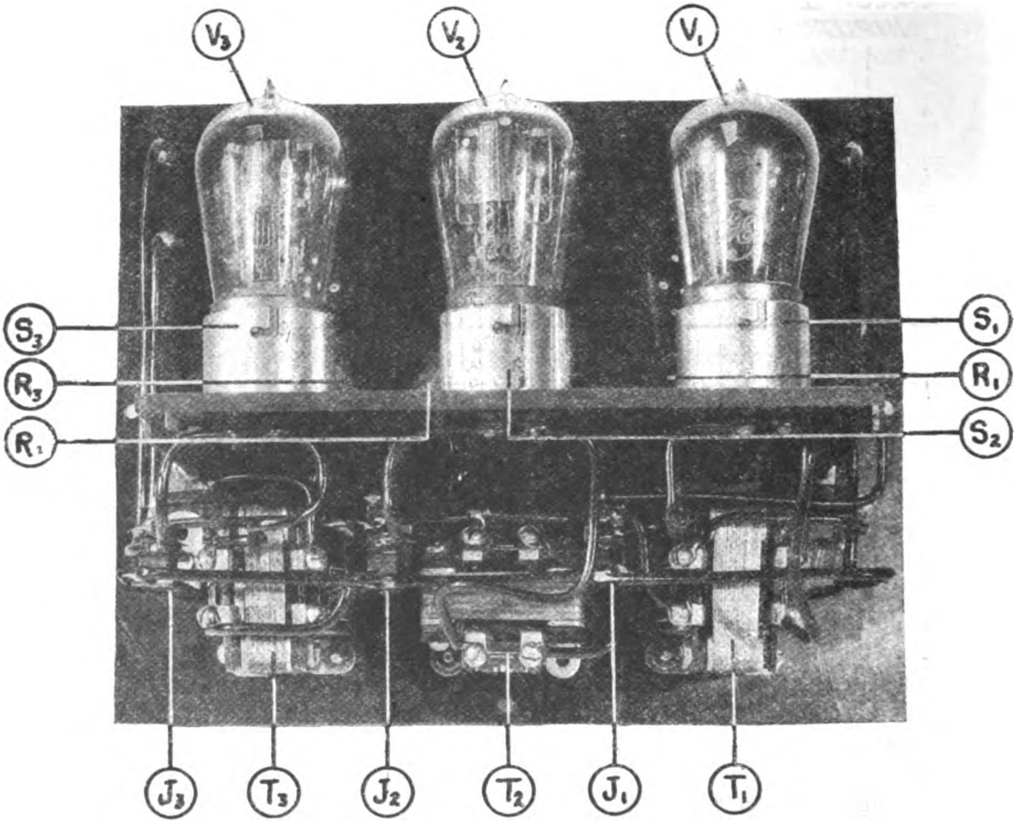
It will be seen that the second tube amplifies the current flowing in the plate circuit of the first tube and supplies this amplified current to a second transformer, T^2, which also steps up the voltage of the impulse as shown in Circuit 5, supplying the grid of tube V^3 with a larger voltage than that applied to tube V^2. Compare A^1 and A^{11}. This in turn produces a still greater response in the plate circuit of tube V^3, Circuit 6, shown at B^{11}.

Now, the problem before us is to get the plate current variations as large as possible; that is just what we have done, as is shown when we compare the currents B, B^1, B^{11} in the plate circuits of the three tubes. They have been getting larger in each additional stage of amplification.

A further analysis of this action should enable us to see clearly that the phenomena in a vacuum tube is purely a case of cause and effect. The cause is the voltage applied to the grid and the effect is the corresponding current which flows in the plate circuit. In our diagram the causes are shown at A, A^1 and A^{11} and the effects at B, B^1 and B^{11}. If we increase the cause as at A^1, we get a greater effect, B^1, and if we further increase the cause as at A^{11}, we get a still greater effect, B^{11} The increase in the cause is accomplished by the transformers which step up the voltage of the succeeding impulses, and the effect is increased by the relay action of the vacuum tubes themselves.

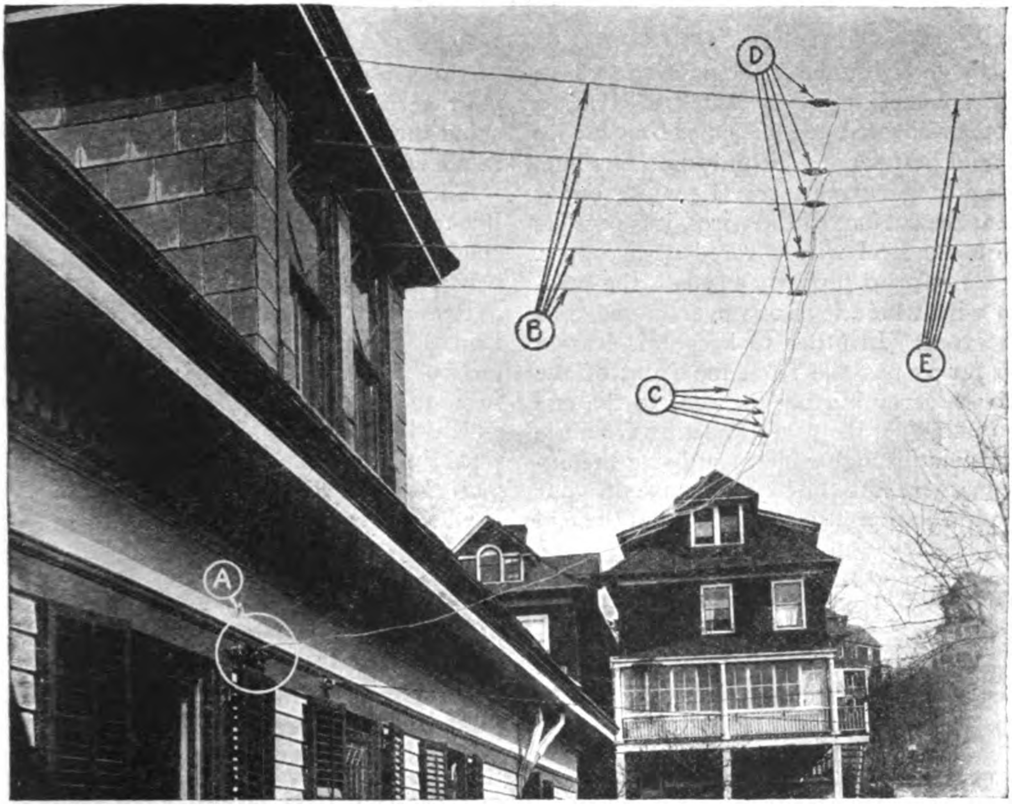
This amplification is done at an audio frequency, because the amplifying transformers pass the audio frequency impulses with facility, but hold back the radio frequency component of the current, not allowing it to flow through their windings.

In our next article we will study the radio frequency method of amplification which has the peculiar property of amplifying weak signals that cannot be heard with audio frequency amplification, no matter how many stages are used.



HOW THE "INSIDES" OF A THREE-STAGE AMPLIFIER ARE MOUNTED

The tubes used are generally mounted on a shelf in back of the panel; they are shown here as V_1, V_2, V_3; they are the tubes for the first, second and third stages, respectively. The sockets are designated as S_1, S_2 and S_3. Only a small portion of the three rheostats can be seen, R_1, R_2 and R_3. The three amplifying transformers, T_1, T_2 and T_3, and the jacks J_1, J_2, J_3, are fastened to the panel underneath the shelf.



THE LEAD-IN END OF A WELL-CONSTRUCTED ANTENNA
A is the lightning switch; B the supporting wires; C the lead-in wires which are joined together to form a common lead-in; D the insulators and E the antenna wires that run to another set of insulators and supporting wires or ropes. It will be noted that the antenna is placed out from the tin roof of the house a distance of at least fifteen feet; this is done by lengthening the wires or ropes B.

Pointers *for* Building Your Aerial

By FRED WOODWARD

AERIALS are the ears and mouth of a radio station. Their position and the way they are hung materially affect the distance from which the radio waves may be received.

The ideal location for an aerial is a low, bare hill, as far as possible from other tall objects such as trees, chimneys, telephone wires or tall buildings.

But these perfect conditions are seldom, if ever, encountered at the particular place at which you are obliged to erect the aerial. In this article, therefore, we will assume that the site of your proposed antenna is the only kind that most often may be taken advantage of—the roof. Two convenient objects to which you can attach the supporting poles are a chimney and the covering to the door leading to the roof. Steady these poles with guy ropes fastened to the coping of the roof or to the roof top itself.

If the aerial is to be a comparatively short one, copper wire will do for the purpose. However, copper wire has a tendency to stretch, so that if you are lucky enough to be in the position to have an antenna at least 100 feet long a copper-covered steel phosphor-bronze wire would best serve your purpose. As high frequency currents travel mainly on or near the surface of the wires, it is possible to use a steel wire covered with copper.

Be sure to properly insulate the lead-in wire where it passes over the edge of the roof. In order to keep this lead-in as far as possible from the front of the house, carry it from the roof to the end of a six-foot flagpole projecting from the window through which you bring the antenna wire into the house or take off your lead-in joint a little distance from the end of the aerial. See that the insulators on your aerial are strong enough to withstand the strains of supporting the aerial in all weathers.

The flat topped aerial, as shown in the illustration on page 109, is better than the single wire aerial in cases when a great height cannot be obtained.

Remember that all flat topped, or horizontal forms of aerial possess a "directive" tendency. It is advisable, therefore, to have the end of the aerial at which the lead-in is fastened pointing toward the broadcasting station from which you expect to do the most receiving. A good antenna is half the battle.

DON'TS

DON'T try to master radio all at once. Begin with the simplest things and work up.

* *

DON'T hesitate to ask questions. Ignorance is no disgrace and dealers and manufacturers are glad to give advice.

* *

DON'T expect to have as little trouble in summer as in winter. Static is far more troublesome in warm weather than in cold.

* *

DON'T listen to the advice of beginner friends who know no more than yourself.

* *

DON'T forget that radio is simple but that common sense is as necessary as with anything else.

* *

DON'T forget the importance of little things.

* *

DON'T be in such a hurry to try your set that you skimp things and make slipshod connections.

* *

DON'T try to drive tacks or nails into Bakelite or hard fibre. Drill holes and use screws.

DON'T forget that the wires on a coil may be kept evenly spaced by winding cotton twine between the wires.

* *

DON'T run wires parallel when making a set.

* *

DON'T try to ground a set on an indoor electric light or bell circuit.

* *

DON'T forget that the positive pole of the "B" battery is connected to the plate circuit of your tube.

* *

DON'T forget that if the tube looks blue you have too much "B" battery.

* *

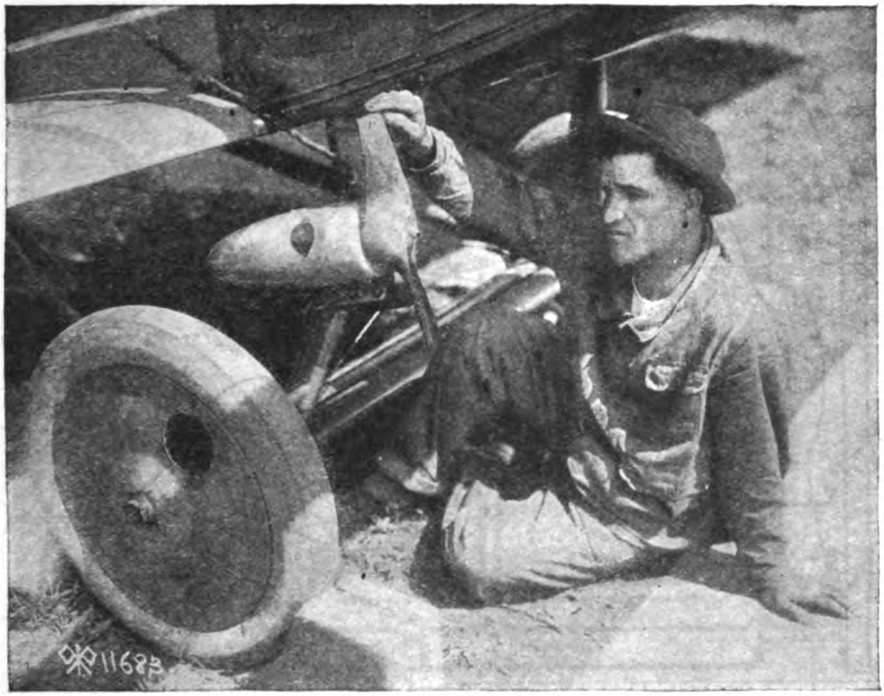
DON'T forget to mark the adjusting knobs or handles when you get the set tuned to a certain station. It will save time in picking it up next time.

* *

DON'T fail to learn the dot and dash code. You will get far more pleasure from your set if you can read them.

* *

DON'T get wires tangled and snarled. A kink in a wire will cause it to crack or break.



THE GENERATOR THAT SUPPLIES THE ELECTRICAL IMPULSE

It is operated by a propeller-like fan beneath the fusilage; incidentally this device furnishes heat to the uniform of the aviator who flies in high altitudes.

A Radio Helmet for an Aeronaut

By STEPHEN LEE

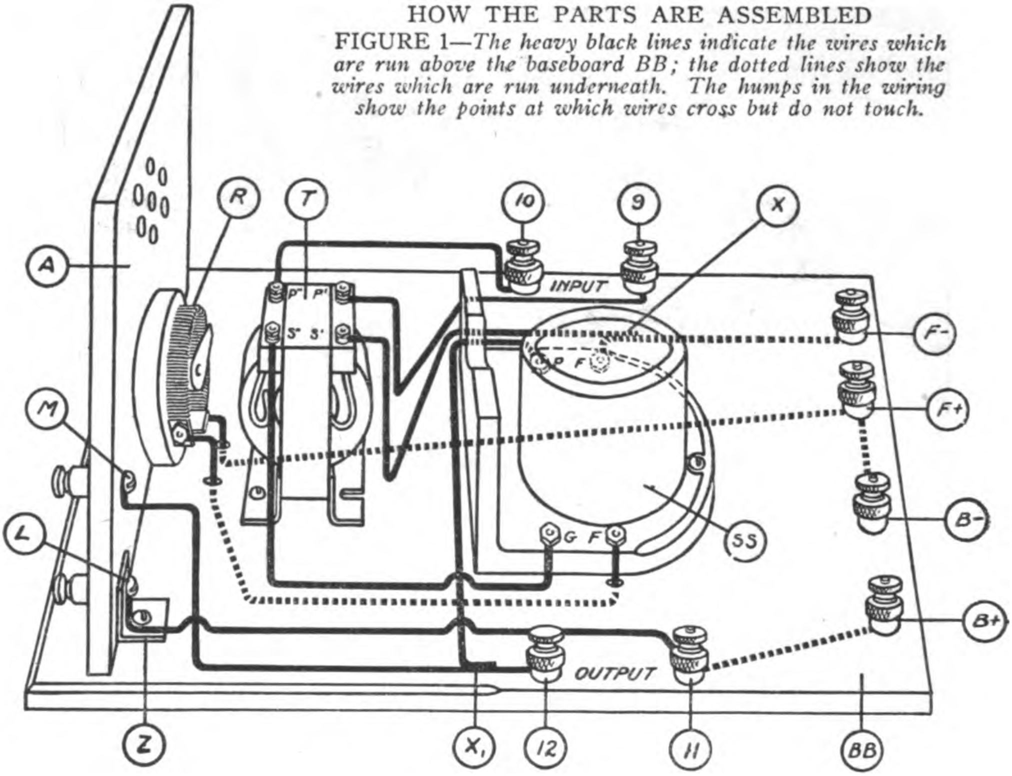
WHEN Lieutenant John A. Macready attempts to shatter the previous sky-climbing record—flying an airplane to a height of 40,800 feet—he will introduce a helmet recently designed by the Air Service of the United States Army. The scientific appliance is at once a means of supplying oxygen necessary in sustaining life at excessive levels in the atmosphere and a mouthpiece that contains a transmitting microphone. Combined with this device are two telephone receivers that are easily adjustable over the ears.

The electrical impulse for the functioning of the radio-telephone equipment is derived from a generator that is actuated by a propeller-like fan affixed beneath the airplane, as illustrated in the accompanying picture. This electrical generator likewise serves the purpose of radiating heat to the Esquimo-like uniform of the aviator, which he wears as protection against the intense cold of this high altitude. The highest attained by Lieutenant Macready may be graphically visualized by his ascension to Mount Everest—the "roof of the world"; this peak is 29,000 feet high, yet the Government aviator climbed two miles in excess of that height.

The newly-designed helmet that couples the functions of supplying oxygen and communication by radiotelephony, is, of course, applicable only when extreme altitudes are the objectives sought. However, the possible use of radio equipment in the atmosphere at such high levels demonstrates still another application of this form of communication, and indicates its practical features for arctic exploration.

HOW THE PARTS ARE ASSEMBLED

FIGURE 1—*The heavy black lines indicate the wires which are run above the baseboard BB; the dotted lines show the wires which are run underneath. The humps in the wiring show the points at which wires cross but do not touch.*



HOW TO ADD TO YOUR SET

AN AUDIO FREQUENCY AMPLIFIER

Do You Want to Dispense with Your Headphones and Use a Loudspeaker? This Article Tells You How to Do It—at a Cost Ranging from $30.05 to $45.30

By DAVID LAY

THE amplifier described in the following directions may be used with the single-circuit radio receiving set described in the May issue of POPULAR RADIO, or with the two-circuit radio receiving set described in the July issue, or with any other tuning device equipped with a detector. The detector may be either a crystal detector or an electron tube detector.

Many radio receiving sets include either a radio frequency or an audio frequency amplifier. A radio frequency amplifier amplifies the radio frequency signal before it is detected (or rectified) by the crystal or electron tube detector, while an audio frequency amplifier amplifies the rectified signal after it leaves the crystal or electron tube detector. The essential parts of either type of amplifier are the amplifying transformer and the electron tube.

These directions tell how to construct an audio frequency amplifier unit—that is, an amplifier that employs a single electron tube. The amplifier unit is used by connecting it to the receiving set in place of the telephone receivers and then connecting the telephone receivers to the output of the amplifier.

The audio frequency amplifier unit is added to the tuner and detector so that the radio power received by the antenna may be transformed into sound in greater volume than would be possible by the use of a crystal or electron tube detector alone. The use of such an audio frequency amplifier unit increases the receiving radius of the outfits described in previous articles of the series by approximately fifty per cent. Still greater receiving radius may be obtained by adding another amplifier unit just like the first one. It is usually not practical to use more than two stages of audio frequency amplification—that is, two audio frequency amplifier units.

One of these amplifier units added to a regenerative receiving set increases the volume of sound in the telephone receivers.

Since a circuit including a crystal detector or simple electron tube detector will not make continuous-wave signals audible in the telephone receivers, the addition of an audio frequency amplifier to these circuits will not accomplish this result.

The cost of this audio frequency amplifier unit, complete with an electron tube, is between $13.00 and $21.00. This does not include the cost of batteries. If an electron tube detector is used in the receiving set, the same batteries are used for the amplifier unit. If, however, a storage battery for lighting the tube filament is not already available, this item will add from $15.00 to $22.00 to the estimate; and if dry batteries are not already available, the addition of two dry batteries for supplying voltage to the plate of the tube will add from $2.00 to $3.00 to this estimate. The cost of the tuner, crystal detector, telephone receivers and antenna equipment which are usually used with this amplifier is between $11.00 and $23.00. If the electron tube detector unit described in the November number of this magazine is used in place of the crystal detector, the cost of the complete equipment is increased by an amount varying between $7.00 and $13.70.

These directions tell of simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers.

The Amplifier

The audio frequency amplifier unit as shown in Figures 1, 2 and 3 is composed of a baseboard BB and an upright panel A. On the baseboard BB is mounted an electron tube socket SS, an audio frequency amplifier transformer T and eight binding posts. On the upright panel A is mounted a filament rheostat R (the adjusting knob J is shown in Figure 3) and two telephone receiver binding posts, L and M. Figure 2 shows the arrangement of these parts. These directions tell how the various parts are assembled on the baseboard and panel. No description is given of the construction of any of the parts.

The Accessories That You Will Need

Under this heading may be listed a six volt storage battery ("A" battery) with an ampere-hour capacity of about 60, used for lighting the electron tube filament; a 45 volt dry battery ("B" battery) for supplying the electron tube plate voltage, binding posts, stiff copper wire (tinned wire is usually preferable), wood boards for the baseboard and upright panel; two brass angle braces for supporting the upright panel, miscellaneous wood screws and suitable stain and varnish. A composition insulating material panel is sometimes substituted for the wood panel and the amplifier unit enclosed in a wood cabinet with a hinged cover. When the cabinet is added the eight baseboard binding posts are left exposed.

Description of the Parts

The baseboards—(See Figures 1 and 3.) The base BB is any kind of dry, well-seasoned wood about 6¼ inches by 8¼ inches by ½ inch thick. Eight holes are drilled through the base in which the binding posts are fastened. The binding posts are spaced so that they present a neat appearance. The baseboard is arranged so that the three remaining sides and a hinged cover may be added without changing the positions of the binding posts. Under each of the four corners of the baseboard BB rubber or wood feet are fastened in order that the binding-post heads and wiring on the under side of the baseboard will be protected.

Upright panels—(See A, Figures 1 and 3.) The panel A is any suitable dry, seasoned wood about 4½ inches by 5 inches by ⅜ inch thick. In Figure 1 a back view of the panel is shown which brings the two holes for the telephone

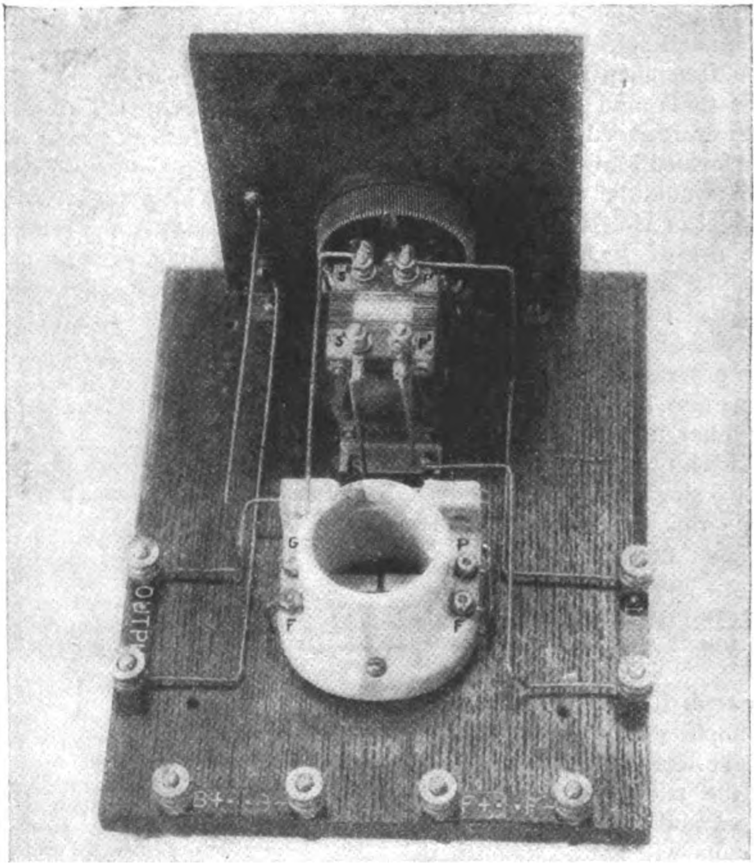


FIGURE 2

Here is shown the rear view of the completed apparatus, with the instruments, binding posts and wiring in place. The amplifier used for this illustration was made with an ordinary set of tools.

receiver binding posts L and M in the lower left corner. (If the panel is viewed from the front these two holes will be at the lower right corner.) This panel is made to present a good appearance, as it is the front panel. Four holes are drilled in the panel A, one for the bolt which fastens the panel to the brace (see Z, Figure 1), two for the telephone receiver binding posts L and M (Figures 1 and 3), and one for the shaft of the filament rheostat R (see Figure 1). The exact location and diameter of the hole for the rheostat shaft is determined from the rheostat itself. It is drilled so that the rheostat occupies as low a position as possible, allowing room enough to do the necessary wiring.

The electron tube—(See Figure 3.) The electron tube is a commercially available tube generally called an amplifier tube or "hard" tube.

The electron tube socket—(See SS, Figures 1 and 3.) The electron tube socket is one of various commercially available types.

The audio frequency amplifier transformer—(See F, Figure 1.) The audio frequency amplifier transformer is one of the various commercially available types.

The binding posts—The binding posts used on the baseboard are 6-32 or 8-32 brass machine screws, each equipped with two nuts and two washers, if regular binding posts are not used. The telephone receiver binding posts, L and M (Figures 1 and 3) are of the set-screw type to admit the tips of the telephone receiver cords.

The filament rheostat—(See R, Figure 1.) The filament rheostat is one of the various commercially available types designed for panel mounting, and has a neat appearing knob and pointer. The rheostat has a resistance of about seven ohms and a current-carrying capacity of about 1½ amperes.

Accessories—The accessory batteries are commercial articles. The purchaser of the six volt storage battery ("A" battery) for lighting the filaments should get full instructions from the dealer for testing and recharging the battery. The 45 volt "B" battery usually used for the plate circuit cannot be recharged. The normal life of a dry battery of reliable manufacture is about six months. Storage batteries for use as "B" batteries are available. The first cost of these batteries is greater than that of dry batteries, but they may be recharged.

How to Assemble and Wire the Set

Wood finish—It is essential that the wood be protected from moisture. The wood is first dried, and then finished with stain and varnish; a good grade of varnish, preferably insulating varnish, is used. Shellac or other alcohol-dissolved resins are not used. This method of wood finishing is found more satisfactory than treating with paraffin. The exact method of drying and finishing wood depends upon the condition of the wood itself. The wood is usually placed in a warm oven for an hour or so to insure more or less complete drying. The use of lamp black or carbon pigment stains is avoided, and the stain and varnish is thoroughly dried before the apparatus is mounted on the wood baseboard and panel.

The baseboard—(See Figure 1.) The eight brass machine screws or binding posts are put in the holes already drilled in the baseboard. If machine screws are used, the heads are put on the under side of the baseboard with a brass washer between the head and the baseboard. A brass washer and two nuts are then fastened to each screw, on the upper side of the baseboard, with the washer next to the baseboard.

The tube socket, SS, and the transformer T are next screwed to the baseboard. The exact location of these parts varies according to the particular type used. One may get an idea of the relative position of the several parts from Figure 2. The tube socket, SS, is mounted so that the two terminals marked G and P (Figure 1) are nearest the upright panel. Wood blocks are put under the socket SS, when necessary, so that the four terminals of the socket do not touch the wood baseboard. This is done by cutting off two round wood blocks just long enough to raise the socket terminals clear of the base, and mounting them so that the screws which hold the socket to the baseboard will pass through holes in the centers of the blocks.

After the socket SS and the transformer T are mounted, the parts are wired. Number 14 bare (preferably tinned) copper wire is used in wiring; this makes the connections stiff and self-supporting. This wire is ordinarily furnished in rolls and is straightened before being used. This is accomplished by clamping or otherwise fastening one end of the wire solidly and pulling on the other end just hard enough to stretch the wire slightly. All wires are run as directly as possible, consistent with good spacing and neat appearance, and all bends are made at right angles. When a wire is attached to a binding post, a loop or eye is formed on the end of the wire and the wire at the eye flattened with a hammer. This gives more contact surface. Special lugs are sometimes soldered to the ends of the wires before the connections are made.

A small hole is drilled through the baseboard near each of the tube socket terminals marked F (see Figure 1). A short piece of wire is fastened to the right socket terminal marked F and is then led through the small hole in the baseboard to the under side of the baseboard. The same wire is led to the under side of the binding-post marked F—and fastened between the machine screw head and washer underneath the baseboard. All wires which are run on the under side of the baseboard or are hidden by parts of the apparatus are shown by dotted lines. A wire is soldered (at X) to the wire leading from the right socket terminal marked F, just above the baseboard and led to the secondary terminal S of the transformer T and soldered or otherwise fastened to it. This wire is shown as part solid and part dotted. The wires do not touch the wood boards except at the terminals and where the wires pass through holes in the baseboard. The wires may be raised more or less to accomplish this. Another wire is soldered to a primary terminal P′ of the transformer and led to the "input" binding post No. 9. Humps or bends are shown in this and other wires to indicate that the wires cross but do not touch.

A wire is soldered to the other primary terminal P″ of the transformer T and goes from there to the other "input" binding post, No. 10. A similar wire reaches from the other secondary terminal S″ of the transformer to the electron tube socket terminal marked G. The secondary transformer terminal which connects to the terminal G of the electron tube socket is that terminal which is internally connected to the outside end of the secondary coil of the transformer. This is sometimes determined by inspection. In other cases it is necessary to try out the completed amplifier unit as described under "How to Operate the Set." If good results are not obtained, the wire leading from G to S″ is removed from S″ and connected to S′, and the wire leading from X to S′ is removed from S′ and connected to S″.

A wire connects the binding post B plus and the "output" binding post No. 11, on the under side of the baseboard. The remainder of the wiring is left until the upright panel is assembled and fastened to the baseboard.

The upright panel—(See A, Figure 1.) The filament rheostat R is mounted on the upright panel A so that the two terminals will be in a convenient position for wiring. Two binding-posts of the set-screw type, L and M (Figures 1 and 3) are inserted in their proper holes and the upright panel is mounted in position by bolting it to the two brass angle pieces (Z and Z′), shown in Figure 1. One of the telephone receiver binding posts L serves as a bolt. Two small holes are drilled through the baseboard near the two terminals of the filament rheostat R. A wire is run from the "output" binding post No. 11 (Figure 1) along the upper side of the baseboard to the back of the telephone

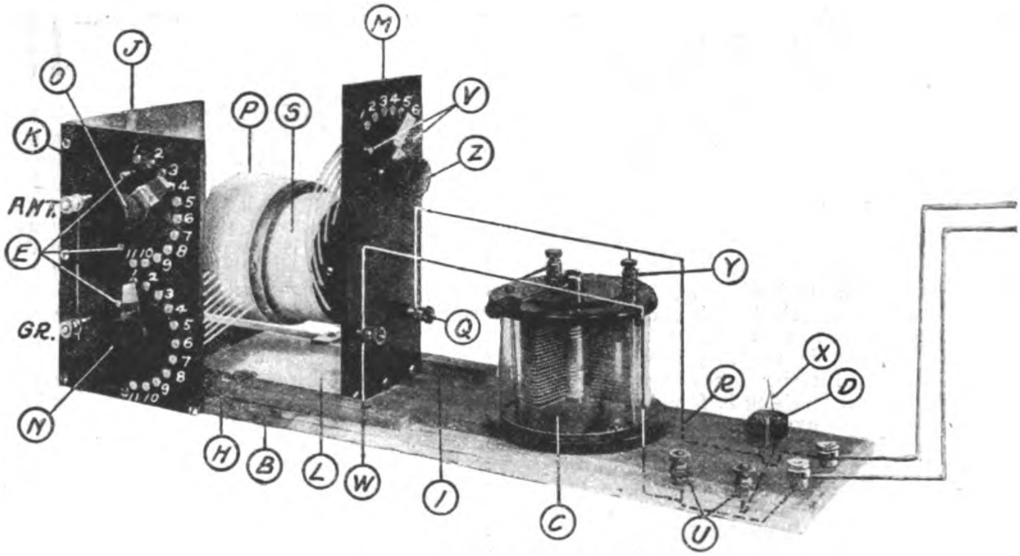


FIGURE 3

On this page and the page opposite is pictured the set complete. Above is the two-circuit tuner; it is connected to the vacuum tube detector shown at the top of the opposite page, and to two stages of audio frequency amplification shown at the bottom of the opposite page. One 6 volt storage "A" battery is used for lighting the filaments of all three tubes and one 22½ volt "B" battery is used on the plate of the detector tube. A separate 45 volt "B" battery is used on the plates of the two amplifier tubes.

receiver binding post marked L. A wire is fastened to the other "output" binding post No. 12 and led to the rear of the upper telephone receiver binding post M. A wire is fastened to the electron tube socket terminal P and led to some convenient point X' on the wire leading from binding post No. 12 to M. The two wires are soldered together at this point.

A wire is run from one of the filament rheostat binding posts through the hole in the baseboard and thence along the under side of the baseboard to the binding post marked F plus and is continued from F plus, still underneath the baseboard, to the binding post marked B minus. (This wire is shown in Figure 1 by a dotted line.) Likewise a wire is run from the other rheostat binding post, underneath the baseboard and up through the left hole in the baseboard at the rear of the electron tube socket SS and connected to the left binding post marked F. This completes the assembling and wiring of the audio frequency amplifier unit.

How to Make the Connections

If the two-circuit tuner and the electron tube detector are used with the audio frequency amplifier unit, the several parts are arranged and connected as shown in Figure 3. Two amplifier units are shown making a two-stage amplifier. If only one unit is used the connections are correspondingly simple. Increasing the number of "B" batteries used to supply voltage to the plates of the amplifier tubes will usually increase the intensity or loudness of the amplifier radio signals, but at the same time the quality of the tone will be slightly impaired.

The voltage should never be increased to as much as twice the rated plate voltage of the electron tube.

The two-circuit tuner and the tuning condenser C (shown at the left) are described in the July issue of POPULAR RADIO.

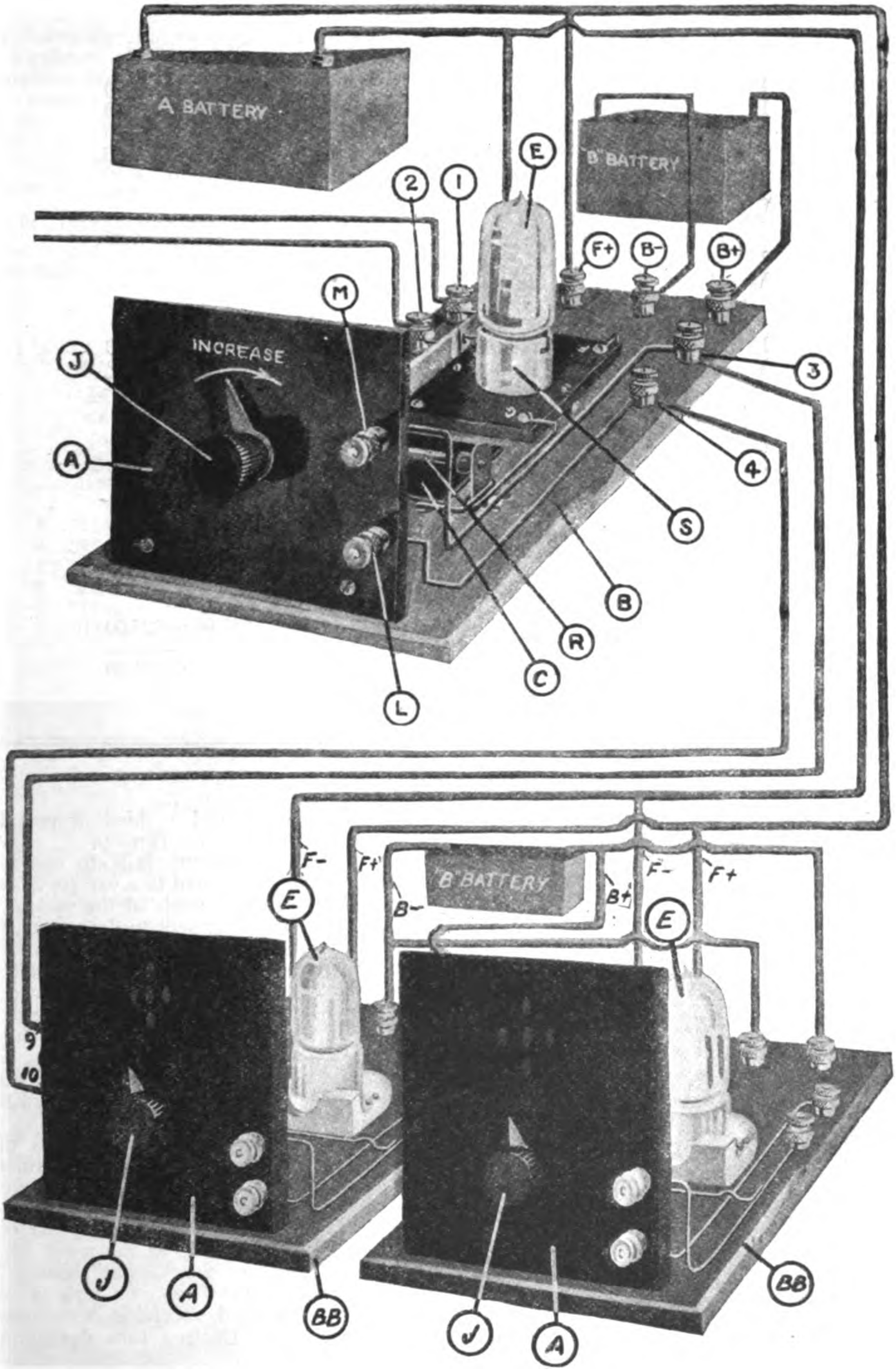
If the single-circuit tuner and electron tube detector are used with the audio frequency amplifier, the arrangement of the parts is also similar to that shown in Figure 3, except that the single-circuit tuner replaces the two-circuit receiving set. The binding posts, 5 and 6, on the single-circuit tuner are connected to the electron tube detector binding posts Nos. 1 and 2 respectively.

The connections to the "A" and "B" batteries are the same as shown in Figure 3. Great care is taken to see that the "B" or plate battery is *not* connected by mistake to the binding posts marked F plus and F minus. This battery has too high a voltage for the electron tube filament and will burn it out.

The antenna and ground wires are connected as shown in Figure 3.

How to Operate the Set

The two filament rheostat knobs marked J (Figure 3) on the two audio frequency amplifier units, and also the filament rheostat knob on the electron tube detector unit, are turned to the extreme left or to the "off" position. Two electron tubes marked E ("hard" or amplifier tubes) are inserted in the sockets of the amplifier units (Nos. 1 and 2) and a third


A BATTERY
"B" BATTERY
E
2
1
F+
B-
B+
M
INCREASE
J
A
3
4
S
B
R
C
L
F-
F+
B-
"B" BATTERY
B+
F-
F+
E
E
9
10
J
A
BB
J
A
BB

This Is What the Material *for* the Set Costs

Electron tube ("hard," amplifier)		$ 6.50 to $ 6.50
Electron tube socket		0.25 to 1.50
Filament rheostat		0.50 to 2.50
Audio frequency amplifier transformer		5.00 to 8.00
Ten (10) feet No. 14 bare tinned copper wire (about)		0.10 to 0.10
Eight (8) binding posts, broad contact type		0.40 to 1.20
Two (2) binding posts, set-screw type (for telephone cord tips)		0.15 to 0.40
Miscellaneous wood screws (about)		0.10
Wood (hard, for base and panel)		
One (1) piece 8¼x6¼x½ inches		
One (1) piece 5x4½x⅜ inches		
Four (4) rubber feet (about)		0.05 to 0.10
Wood (for cover)		
Two (2) pieces for sides 7¼x5x½ inches		
One (1) piece for back 5x3¾x½ inches		
One (1) piece for top 7¾x5¼x½ inches		
Two (2) hinges for top, ¾ inch		
Stain and varnish, solder, soldering flux		
		$13.05 to $20.30
"A" storage battery, 6 volt, 60-ampere hour	$15.00 to $22.00	
Two (2) "B" batteries, 22½ volts each	2.00 to 3.00	$17.00 to $25.00
Total Cost		$30.05 to $45.30

electron tube (preferably a "soft" or gas tube) is inserted in the socket of the electron tube detector unit. The three filament rheostat knobs are then turned to the right until the filaments of the electron tubes become lighted, the brilliancy depending upon the type of electron tubes used. When one of the telephone receiver terminals is removed from its binding post (either L or M) and again touched to the post, a sharp "click" in the telephone receivers will be an approximate indication that the circuit is in working condition.

When the signals from a desired transmitting station are heard as loud as possible by tuning, the intensity is sometimes improved by adjusting one or more of the knobs on the filament rheostats so as to increase or decrease the filament current (current from the "A" battery). The knobs are kept in the positions of minimum filament currents without reducing the strength of the incoming signals.

If the electron tube detector unit is equipped with a "soft" or "gas" tube, the voltage of the "B" battery is changed until the greatest signal intensity is obtained. This necessitates the use of a tapped "B" battery.

When two audio frequency amplifier units are used a continuous "howl" is sometimes produced in the telephone receivers. In this case the wires leading to the "input" binding posts of one or both of the amplifier units are reversed; that is, binding post 3 is connected to binding post 10, and 4 to 9, and binding post 11 of amplifier No. 1 to binding post 10 of amplifier No. 2 and also 12 to 9.

In case the apparatus fails to operate the trouble may be attributed to a variety of causes. An inspection is first made of the various parts of the receiving equipment to determine if they are properly connected, special care being taken to see that the positive (plus) and negative (minus) terminals of the "A" battery are connected respectively to the binding posts marked F plus and F minus, and that the positive (plus, red) and negative (minus, black) terminals of the "B" battery are connected respectively to the binding posts marked B plus and B minus.

To determine if the various parts of the receiving circuit are in working condition the telephone receivers are removed from the phone binding posts on the amplifier unit and connected to the phone binding posts on the tube detector unit. One of the wires which is connected to one of the "output" binding posts of the electron tube detector unit is temporarily removed and receiving tests made to determine if the electron tube detector is in working condition.

The telephone receivers are next connected to the phone binding posts on amplifier No. 1, the wire reconnected to the "output" binding post of the electron tube detector unit, and one of the wires disconnected from one of the "output" binding posts (11 or 12) of amplifier No. 1. Receiving tests are then made to determine if amplifier No. 1 is working properly.

The telephone receivers are then removed from amplifier No. 1 and attached to amplifier No. 2. The wire is reconnected to the "output" binding post of amplifier No. 1. The connections are now as shown in Figure 3.

If the crystal detector is used the same general scheme of testing is followed.

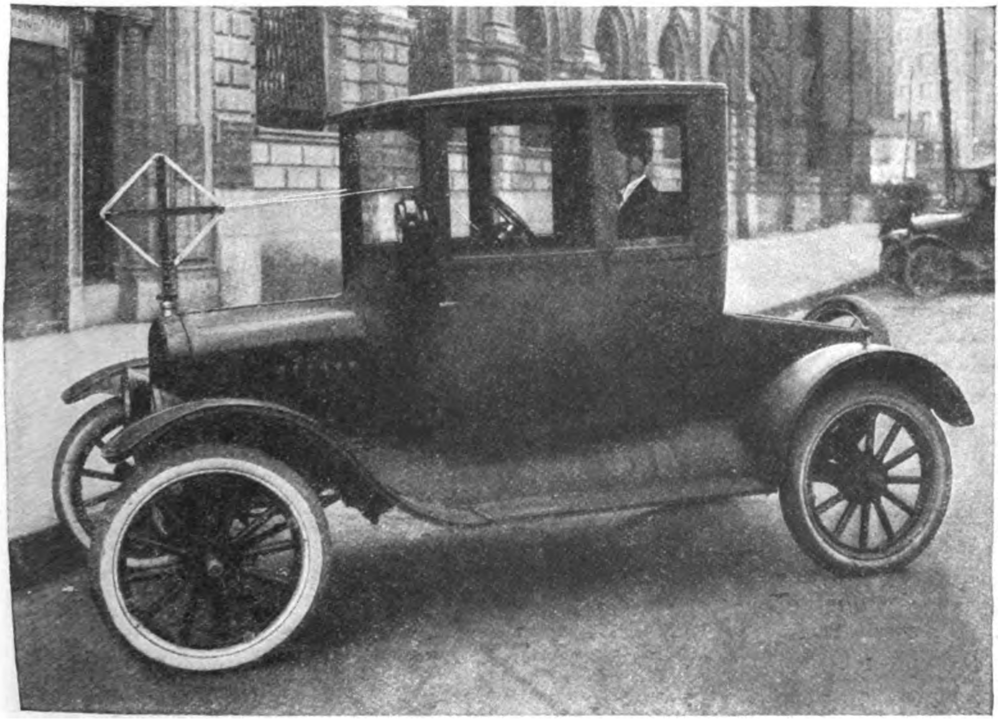
The Approximate Cost of Parts

The list on page 118 gives the cost of parts of one audio frequency amplifier unit and the "A" and "B" batteries; it does not include the cost of the telephone receivers or of any of the other equipment used to make up the outfits described in the previous articles of the series. Some of the parts are the same as listed in the electron tube detector circular with some of the prices revised. If audio frequency amplifier units are used with the electron tube detector unit the same "A" and "B" batteries are used, except that if a single "B" battery is used with the electron tube detector unit, one additional "B" battery is required.

Uncle Sam's "How to Make" Articles for the Amateur

In order that our readers may take full advantage of the plans and specifications for radio apparatus that have been worked out for the special benefit of radio amateurs and novices by the Bureau of Standards in Washington, a complete list of them is here given, together with the issues of Popular Radio in which they have been published:

1. "How to Make and Install Your Own Receiving Set" in *May, 1922.*
2. "How to Make and Operate a Two-Circuit Receiving Set" in *July, 1922.*
3. "How to Add a Vacuum Tube to Your Crystal Set" in *November, 1922.*
4. "How to Make a Series-Antenna Condenser" in *December, 1922.*
5. "How to Make a Telephone Condenser" in *January, 1923.*
6. "How to Add to Your Set an Audio Frequency Amplifier" in *February, 1923.*



A HENRY WITH A NOSE FOR MUSIC

In other and more scientific terms, this illustration shows how a loop antenna may be attached to the hood of a Ford car. In this case the loop is not rotary, and in order to attain direction the car must be pointed toward the sending station.

From a photograph made for POPULAR RADIO

INSTALLING THE MICROPHONE IN THE TRENCHES

The problem of locating the "electrical ear" in an auditorium is of vital importance in the new form of broadcasting. At the Century Theatre it was located among the footlights.

SYMPHONIES *by* TELEGRAPH

How the First Great Concert to Be Broadcast with the Help of Telegraph Wires Was "Picked Up" in One State and Transmitted to Another State to Be Sent Out by Radio

POPULAR RADIO sponsors another unique and successful experiment in broadcasting great programs to a great audience

By GEORGE B. CHADWICK

A SIGNIFICANT feature of the broadcasting of this season's concerts by the great City Symphony Orchestra of New York is the fact that they are being broadcast by the "pick-up" system without the use of telephone wires. And they are being broadcast with a clarity and a power and a quality of tone that marks them as perhaps the most successful symphony concerts ever sent out by radio.

The refusal of the American Telephone & Telegraph Company to furnish the land wires and service for the purpose of broadcasting these concerts from the Westinghouse station WJZ left but two alternatives: either the project had to be abandoned (thereby depriving the radio fans of the East of what have proved to be the most popular symphonic programs ever broadcast) or else means had to be found for carrying out the plan without the telephone company.

The success attained last fall in broadcasting from WJZ the side-line reports of the big football games at the Polo Grounds (a project sponsored by POPULAR RADIO) with the aid of wires obtained from the Western Union Telegraph Company, naturally suggested the possibility of using the same methods for broadcasting the concerts. And with the helpful cooperation of the Western Union officials with the Westinghouse experts this plan has been carried into effect with results that have surpassed expectations.

When POPULAR RADIO initiated last summer the project of broadcasting the concerts of the New York Philharmonic Orchestra through WJZ it created a demand for good music and established a precedent that has been met with increasing and encouraging emulation throughout the country. This experiment demonstrated a possibility of radio broadcasting which had not, up to that time, been generally realized. The interest aroused by the Philharmonic concerts spread over the entire United States and stimulated a demand for such classical music as comes within the popular range. It was to meet such a demand that the City Symphony programs were planned, and it is especially fitting, therefore, that the range of its series of "popular concerts" should thus be indefinitely widened to include the largest possible audience—a place which is directly in line with the purpose of the patrons of the new orchestra.

For the City Symphony Orchestra is new; indeed, it is the youngest of the three important organizations of its kind in New York. It was founded by the Musical Society of the City of New York to fill a definite and important need in the musical life of the city—that of bringing music, particularly orchestral music of

From a photograph made for POPULAR RADIO

THE NEWEST INSTRUMENT IN THE ORCHESTRA

This is the amplifying apparatus, which regulates the volume of sound that is sent over the wire from the concert auditoriums to the broadcasting station. The operator (who is located among the musicians) is Raymond M. Guy, better known as announcer OGN at WJZ station.

From a photograph made for POPULAR RADIO

THE NEW VACUUM TUBE USED FOR BROADCASTING THE CONCERTS

This triode was developed by the Westinghouse company for the express use of its broadcasting station. The old type of tube is shown at the elbow of the operator—who is known to radio fans as announcer OBN of WJZ station.

the highest standard, within the reach of the general public. Its personnel consists of eighty-three players. To attain the object of its founders, only a modest admission fee is charged for its concerts, particularly so for the "Pop" concerts, which are being given at three o'clock on Sunday afternoons throughout the winter.

The programs are composed of the gems of the lighter classics, together with short symphonic pieces. Such music, experience has shown, is the best fitted for the general music-loving radio public and meets with the widest approval. And on Sunday afternoon the air is comparatively quiet and people like to gather quietly and listen to good music.

The first concert broadcast was given at the Manhattan Opera House on November 25th; the later concerts are being given at the New Century Theater. The series was inaugurated by a short talk prepared by the editor of POPULAR RADIO.

How the mechanical problem of broadcasting a concert held in one State from a radio station located in another State by means of wires furnished by a telegraph company is an interesting story in itself.

First of all, a special wire connecting with one of the regular wires to the Western Union's terminal station at Walker Street was strung to the microphones and the amplifier, located on the stage of the theater. The wire is equipped with a special type of protective device to keep outside interference down to a minimum. From Walker Street the relay is made to WJZ in Newark on a special circuit which has been set aside for broadcasting—the circuit that was used for broadcasting the World Series of baseball games and the Polo Grounds football games. (Details concerning this special circuit were given in the January issue of POPULAR RADIO.) It is safe to say that the helpful experimental work of the Western Union on this circuit has played a considerable part in the splendid transmission of these notable concerts.

At the theater itself are placed four microphones. One is located at the left of the stage in the wings for the operator of the switch box, who also serves as the announcer; a second microphone is placed at the right of the stage, hung about twenty-five feet high and facing the audience in order to catch the applause; a third instrument is located at the outer edge of the orchestra pit for the soloists; and a fourth—the most important of all—is placed at the footlights in front of the orchestra.

The placing of a microphone so that it will most effectively catch the multiplicity of sound that comes from an orchestra of eighty-three pieces, or for that matter the placing of a microphone to catch the sounds of any group music, is a problem still in its infancy. As time goes on there undoubtedly will be rearrangement of the pieces in orchestras to more effectively bring to the microphone the sound waves in their true values. Another problem that has also just begun to be studied is the question of acoustics from a radio standpoint. It is possible that in the building of future concert halls and opera houses this problem will be given special consideration.

The radio signals are amplified at the theater; at the Newark station they are further strengthened by other amplifiers. Here there is also a special filter circuit to improve the quality of sound before it is amplified.

The story of these City Symphony concerts is not a story of long-distance broadcasting. It cannot be, as the daytime broadcasting radius does not extend much over two hundred miles. The development of long-distance broadcasting is one of the big problems before the radio world, but so, too, is the question of the kind and quality of broadcast entertainment, and, though these concerts reach out through a fairly broad radius, the important factor is that they constitute entertainment that can be classed as of permanent cultural value, broadcast over an area occupied by many millions of people—all of whom are at liberty to "plug in." Yet evidence of the widespread interest aroused has come in letters from points as far north as the city of Toronto in Canada, and as far south as Atlanta, Ga.

FOLLOWING the successful broadcasting of the concerts of the New York Philharmonic Symphony Orchestra last summer (a project initiated by POPULAR RADIO) the management requested this magazine to arrange also for the broadcasting of its series of nineteen Educational Concerts during the present season. Provisions for broadcasting them through the Westinghouse station WJZ were blocked, however, by the refusal of the American Telephone & Telegraph Company to furnish the necessary land wires or service. So much pressure was brought to bear from influential sources to carry this project into effect, however, that the telephone company arranged to broadcast about half of the concerts through its own station, WEAF.

—EDITOR

SCOUTS HAVE MADE USE OF RADIO FOR THIRTEEN YEARS
Practical training in signalling and experience with radio enabled thousands of scouts and former scouts to render valuable public service during and since the war.

MAKING GOOD AMERICANS

Via RADIO

How the Younger Generation of Fans Are Being Drilled to Render Service to Uncle Sam

BY ARMSTRONG PERRY

RADIO has been a part of boy scouting ever since the scout idea swept over our country in 1909.

Signalling is a major activity with scouts. They often begin with the semaphore because it is easy to learn and because it requires no apparatus but a pair of arms. But the International Morse or General Service code soon follows. This is wigwagged with flags, tooted on trumpets, ticked on telegraph machines and whee-e-e-d from scout whistles. And sooner or later one or two scouts in each troop graduate into radio.

First class scouts who rise to the dignity of official radio operators for their troops go still further and earn the "merit badge in radio." Their text book is the merit badge pamphlet of the organization, revised and brought up to date by S. Kruse, one of the best known and most popular of American technical radio amateurs, who has tipped the scouts off on the vacuum-tube transmitter and all the latest wrinkles. Before the revision the advice of officials in the Army, Navy, Department of Commerce, Bureau of Standards, Post Office Department, Department of Agriculture and Bureau of Education, and others interested in radio, was secured in order that the radio policy of the scout organization might coordinate with the Government's radio policy and system.

Portable radio sets for field work were features of boy scout rallies long before the war. P. B. Colleson had installed and operated a station at the first boy scout camp in the Interstate Palisades Park, in 1914. Lloyd Espenscheid had instructed scouts at the Brooklyn Central Y. M. C. A. before that.

Navy officers naturally turned to the scout organization when the naval operations suddenly absorbed the entire visible supply of radio operators at the beginning of the war. The scout movement had been operating just about long enough at that time so that boys who had become scouts at twelve, thirteen and fourteen years of age had added enough years and experience to be ready for men's jobs. Boy scouts are not given military training, their routine being directed toward developing a practical patriotism and the ability to think and act and take care of themselves and others in the open, but the way they took hold wherever the nation needed them justified the time, money and methods employed. Luther Weaver of Brooklyn, one of the first radio scouts to volunteer for the Navy, went down with his transport off the coast of France.

On the day that war was declared by the United States all owners and operators of private radio stations were ordered to suspend operations and dismantle their apparatus. Some did. It became necessary to hunt down the rest and enforce the order. Radio was already popular and the job of locating stations that had not complied with the order was too large for the Navy personnel available. Hon. James A. Wilder, formerly United States Consul General at Honolulu, had become Chief Seascout of the Boy Scouts of America. He offered his services to the Intelligence division of the Navy and quietly set his scouts at work. In a few weeks they turned in six hundred reports in one city alone—each indicating the presence of an illegal radio station in the vicinity of a Navy Yard.

The Navy did not have enough investigators to follow up these reports. The scouts who made them were asked to continue their investigations and confirm or remove their suspicions. The Navy investigators dealt with persistent violations.

In 1918, when it became apparent that older men might be needed in the Army and Navy, even though lacking in military training, the editor of the official organ of the Boy Scouts of America took

Keystone View Co.

HE TEACHES SCOUTS HOW TO BUILD THEIR OWN SETS

While Armstrong Perry—the author of this article—may install a handsome receiver in his home, he has taught many a boy scout to construct a simple apparatus that has cost but a trifle. One of his pupils built a set that worked for only 21 cents.

a course in radio in New York. Later, on a Navy transport, he discovered two operators who had received their first radio training in the same Boy Scout troop in New Orleans. They had been members there at different periods and did not know they were troop-mates until they learned it from the scout official.

The editor, convinced by this and other experiences that someone at the national office ought to keep pace with and encourage the radio scouts, installed a receiver at his home on Long Island as soon as war-time restrictions were removed. One night while exploring the ether he discovered the Amateur Broadcast which has been transmitted evenings for three years by the Radio Amateur Bureau connected with the Staff Headquarters of the Third Naval District. From time to time he acknowledged receipt of these broadcasts and after a while called at the District Communication Superintendent's office to express his appreciation of a service so ideally adapted to the needs of scouts and other beginners in radio. The District Communication Superintendent stated that the Radio Amateur Bureau would undertake to broadcast official messages from the National Council office of the scout organization, for the encouragement of boy scout radio.

The offer was promptly accepted. Reporting it at headquarters, the editor was appointed Seascout Radio Commodore and was given the responsibility for interesting the twenty thousand troops throughout the country in maintaining receiving stations and keeping open a radio channel between the national government and the local communities. In return for the Navy's service the scout organization undertook to interest amateur operators in registering with the Radio Amateur Bureau and many hundreds of amateurs have been registered as a result of scout activity. Amateurs send descriptions of their stations to the Seascout Radio Commodore, 200 Fifth Avenue, New York City, and receive keys to the confidential codes which are used in the transmitting of Amateur Broadcasts.

The Seascout Radio Commodore, believing that the development of a system by which the citizens of the nation could hear from the national government directly and daily, began to stir up interest in such a system long before the advent of the radio telephone broadcast created the present furore. In 1919 he suggested to the Secretary of Agriculture that he provide messages to be broadcasted through the Navy and boy scout system, and he did so. Less than a year later the Agricultural Department and the Post Office Department developed their great system which gives to the farmer the up-to-the-minute market reports that place him on an equal footing with the buyer in a dicker about prices. With the approval of the Navy, the scout organization offered to handle the broadcasts for the American Library Association and the American Red Cross and a number were transmitted from the Navy station in New York. The Third Naval District made arrangements with the First Naval District whereby broadcasts of special importance, submitted by the scout authorities, were forwarded by leased wire to Boston and were broadcast from the Navy Station there also. During the scouts' anniversary week, in February of each year, messages from the President of the United States to the whole organization have been broadcasted from Navy stations all along the Atlantic, Lake, Pacific and Gulf coasts. The first list of radio telephone broadcasting stations of the United States given to the public was compiled by the Seascout Radio Commodore several months before the Department of Commerce found it necessary to restrict broadcasting. Copies were left at the White House and at the offices of the Departments most interested in radio. Within a few weeks the White House and the Cabinet offices were equipped with receivers.

The development of boy scout radio became more rapid from that time. Some

UNCLE SAM'S RADIO EXPERTS OF TOMORROW

But Scouts are trained in more than the mere technical details of wireless; they are trained in the ideals of service that can be rendered to their country and to humanity by the use of radio.

individual scouts made remarkable records. One of them served as official operator at a scout camp in 1919; a little later he built a radio telephone transmitter. Anxious to see if it worked, he connected it to his antenna, turned on the juice, and shouted:

"Hello! Hello! Hello! Is this the Naval Air Station?"

He had no more idea of raising that station than he had of getting a reply from China, but a gruff voice came back instantly:

"Yes, this is the Naval Air Station. What do you want?"

The scout stopped right there. Before he opened up again he made some careful measurements of his wavelength, for at that time the Navy station was supposed to be standing by on 800 meters while the longest wave that he could legally use under the terms of his transmitting license was 200 meters! However, the Navy did not resent the intrusion. Not long afterward the Navy called him one night, told him that transmitter trouble prevented them from reaching a vessel near him off the coast, and asked him to relay the message to the ship. He handled the traffic efficiently and received a commendatory acknowledgment from the Navy. Then he went to sea as a commercial operator for two years, served another season in the boy scout camp, held a job as radio salesman during the first stages of the present radio craze, and received an offer to become the superintendent of a radio manufacturing plant and manage a force of three hundred men. He is not yet old enough to vote, though his experience and appearance make him seem much older.

When the delegation of 375 scouts and scoutleaders embarked on the Army transport *Pocahontas* in 1920 to sail for England and represent America in the International Scout Jamboree, a Miami radio patrol carried its outfit in a trek cart. Seasickness and other troubles interfered somewhat with their plans on shipboard. A member of the delegation sat in a little space outside the ship's radio cabin one night, copying a code message from the Navy station in New York which was sending greetings from the scouts at home to those at sea. The ship's operator was bringing it in loudly enough to be heard twenty feet from the phones, but when a big man in a bathrobe stalked in, his remarks to a friend in civilian clothes created so much interference that the scout unconsciously said:

"Sh-h-h!"

The men went on into the radio cabin. The scout's hair stood on end a moment later when the man in the bathrobe, whom he had tried to hush up, gave unmistakable evidence of being the captain of the ship. But the scout got his message before he slipped out of the door and slid down the iron ladder into the friendly darkness of the lower deck.

The San Diego scouts had two-way radio communication between camp and local headquarters several years ago. In the group of scout camps in the Interstate Parlisades Park, the largest aggregation of boys' camps under one management in America, there has been intercamp radio communication, and the reception of weather reports, time signals and news from Naval stations has been a feature. Philadelphia scouts worked out a radio mobilization plan two or three years ago. Manhattan Borough, Greater New York, was among the first to have a transmitting set at the local council headquarters, and a training class for scout operators was maintained at this point. In Minneapolis the municipal station is manned by sixteen scout operators. East St. Louis had a scout station with a broadcasting range of a thousand miles.

Washington, D. C., has a scout radio training class in charge of Major P. W. Evans of the United States Army Signal Corps; from his desk in the War Department the Major proudly points to a dozen brother officers who are serving as scoutmasters and interesting scouts in radio. During the past summer the Washington scout camp was in radio communication with its headquarters in the city, using regulation Signal Corps apparatus. Monmouth County, N. J., has half a dozen scout radio patrols.

B. T. B. Hyde of the American Museum of Natural History spends his summers directing boy scout museums in the Kanohwahke Lakes group of camps in the Interstate Palisades Park and assisting other camps with their natural science studies. The headquarters radio station of the scouts is under his jurisdiction and last summer he developed a system of broadcasting messages through the Navy and boy scout system for the purpose of stimulating interest in nature study. To pick up a coded message and discover frogs, butterflies and beetles in it was almost as much fun for the scouts as to capture the bugs themselves.

When police departments broadcast descriptions of stolen automobiles there are sure to be some scouts listening in. A scout operator in New England for days copied the license numbers, colors and engine numbers from WGI, which tells the world about the cars that are stolen in Boston, without results. Then one morning on the way to school he found himself face to face with a car that he had a hunch was on his list. Just to make sure he went over his numbers, then a quick report to the police fin-

Brown Bros.

ON "ACTIVE SERVICE" IN THE FIELD

These up-to-date successors of the knights of Old England are following upon the heels of Young America in extending the use of radio; practical training in installing apparatus and in sending and receiving code messages is an important feature of the course of the 2d Royal Eltham troop of scouts in England.

ished his part in locating a stolen car.

In New Jersey two scouts turned the same trick with a truck, getting the description from Sergt. Pearce who at the time was at the key at the New York police headquarters.

A pair of Pittsburgh seascouts—members of the web-footed branch of the scout organization—put one over on the land wire companies. One of them, before starting on a tour that was to take him from New York to Florida by a coastwise steamer, told his chum to listen for a radio message that he was going to send him *via* the regular commercial service at a specified hour. The boy at home listened in and heard the ship's operator as he transmitted the message to a shore station. The telegraph messenger arrived with the same message thirteen hours later!

The Seascout Radio Commodore travels more or less and usually has a radio receiver with him. A scout came to him a few weeks ago to ask questions about the construction of a receiver. The next day he reported that he was receiving, with apparatus that he had made himself, the time signals from the Navy station at Arlington, some code messages which he believed to be weather forecasts, baseball scores and concerts transmitted by radio telephone. The Commodore asked to see the apparatus. It consisted of: 1 oatmeal box; a dozen brass paper binders; 6 paper clips; fifty feet of old bell wire; 1 piece of galena; 1 common pin. This receiver, plus antenna and ground wires, and a pair of phones donated by a friendly army officer, were doing the same work that the Commodore was doing with a manufactured set.

The manufactured set cost $25.00: the scout had spent twenty-one cents!

The Third Naval District now has a special list of scout operators who can send and receive at least twenty words per minute. These are given the low numbers on the register at the Radio Amateur Bureau. From this list, in case of emergency, will be called operators who can assume responsibility without further training except what their daily work will give them. These scouts are not obligated to respond to the call. It has been found unnecessary to bring to bear upon scouts any pressure other than that created by their high ideals of citizenship and service. They take the scout oath and live true to the scout law. When their country needs them their only concern is to find the place where they will fit best.

To national and local officials of the Boy Scouts of America have been extended the courtesies of the great commercial broadcasting stations throughout the country. They frequently address local organizations over broad areas. Turn about is fair play and, while favoring no one concern, the organization does many things that help the radio manufacturer and dealer. The Seascout Radio Commodore, keeping in touch with radio literature, following the development of radio apparatus, visiting all sorts of radio stations, talking with scores of radio users, and carrying on an extensive correspondence on radio subjects, is often in a position to give advice which is valued by commercial radio concerns. He has no commercial connections to prejudice him for or against any radio product.

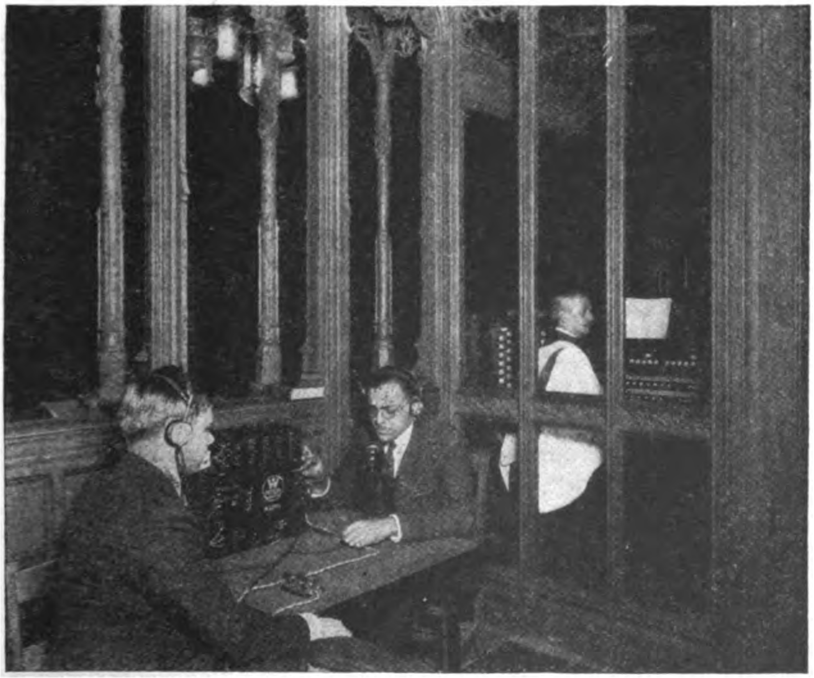
Chambers of Commerce, Boards of Trade and other civic organizations will sometime awake to the fact that they have right at hand the makings of a local radio system that will ensure the reception and local distribution of all the valuable information that is constantly in the air. The attitude of the technical amateur on the one hand and the development of radio as an amusement on the other have obscured the most important possibility of the new means of communication. It would be a simple matter for any city or rural community to establish a complete service that in some ways would be more valuable, because quicker, than that of the local post office and that of the wire lines. There is efficient receiving apparatus in practically every neighborhood. There are operators everywhere who, if not already prepared, could very soon prepare themselves to handle government and other broadcasts for the benefit of the community. They would only need to listen at scheduled hours for the information that the community needs and wants. If it is not in the air there is a strong probability that it would be placed there by some broadcasting station in the territory on request. Once received, the local distribution is only a matter of detail.

Nationally there is already organization enough. The American Radio Relay League has organized the best technical amateurs into a system that shoots a thousand citizen messages over the whole United States every day. Sometimes these are passed from the Atlantic coast to the Pacific with an expenditure of energy less than is required for lighting a common incandescent lamp. The Atlantic has been crossed by fifty-three amateurs in a single night, and now they have attacked the problem of making the Pacific in one jump. They will do it, too. It needs but the interest of a strong local organization, such as a Chamber of Commerce, to get these experts to pause long enough in their technical work to help to organize a less romantic but more valuable system for the reliable reception of broadcasts sent by the government.

The boy scout organization, composed of boys averaging between fifteen and sixteen years of age, has not of course either the highly skilled technical men nor the highly developed apparatus to do what the American Radio Relay League can do. But it has the largest uniformed force in America, traditions that are all associated with public service, and well-established systems of cooperation with our National Government.

Now, if a Chamber of Commerce should suggest to a local American Radio Relay League expert that he rig up a receiver that would bring in the broadcasts from the Navy, Army and Post Office stations and act as big brother to a group of scouts until they had enough competent operators to cover the schedule at that station without placing so great a burden upon any one scout that he would have to neglect his home, church or school duties; if the Chamber of Commerce should ask the scout organization to get those broadcasts every day and telephone them or deliver them by scout messenger to the places where they should be displayed to the public gaze; if the Chamber of Commerce would organize this system, and give it proper encouragement to keep it up to a high state of efficiency, it would go a long way to put its city on the radio map.

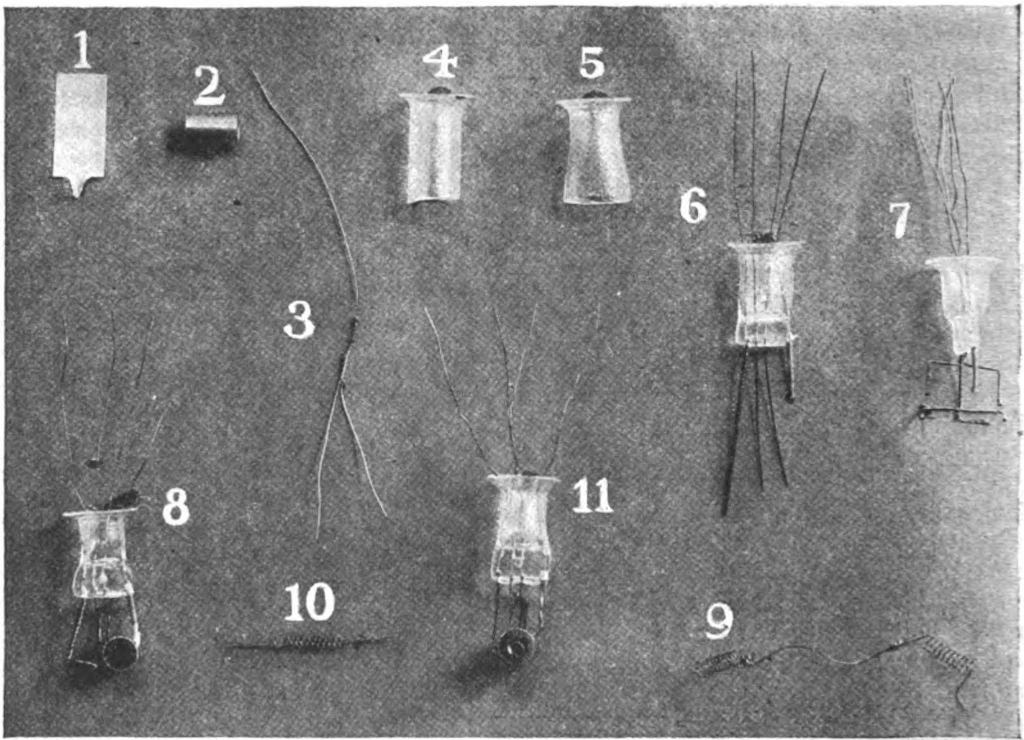
It would do more than that. It would bring up a generation of boys who would realize that doing the same thing every day, unfailingly, just as a railroad sends its expresses over the line on schedule, is a more interesting thing than getting together once a year to hear the mayor tell them what good fellows they are because they put flags on the graves of the soldiers on Decoration Day and held back the crowds along the line of march on the Fourth of July.



Westinghouse

RADIO FANS LISTEN IN ON HIGH SOCIETY AT WORSHIP

When station WJZ broadcast the church services at St. Thomas', located in New York's fashionable social center, microphones were installed at various points in order to transmit every detail, from the sermon to the organ music. The radio apparatus was in charge of Mr. Harry Hiller.



© P. J. Risdon

How John Bull Makes His "THERMIONIC VALVES"

Radio broadcasting is about to begin in England. It will be conducted by a broadcasting company acting under the direction of the Post Office department. No one is permitted to receive except those who own licenses—and licenses are issued only to those who operate British-made sets. The demand for British vacuum tubes (or "valves," as John Bull calls them) is consequently on the rise. The process of making such tubes may be explained thus—

No. 1 shows a small bit of metal cut into the correct shape for the plate of the tube.

No. 2 shows this same plate rolled into the form of a small cylinder.

No. 3 shows the assembly of the grid supporting wires.

No. 4 and *No. 5* show the flanged glass support for the tube elements in the process of preparation for assembly.

No. 6 shows the grid supporting wires, and the filament and plate supports firmly and hermetically sealed into the glass while it is heated and in a semi-molten stage.

No. 7 shows the supporting wires bent into the proper shapes for holding the tube filaments.

No. 8 shows how the plate is fastened to its support.

No. 9 and *No. 10* show the grid in the course of preparation. The wire of which the grid is made is wound in a spiral upon a mandrel to insure the correct size to accommodate the filament wire which will be suspended inside of it.

No. 11 shows the complete internal assembly, with the grid coil and the filament wires in their correct places within the cylindrical plate.

No. 12 shows the glass bulb which has been prepared by the glass blower ready for assembly.

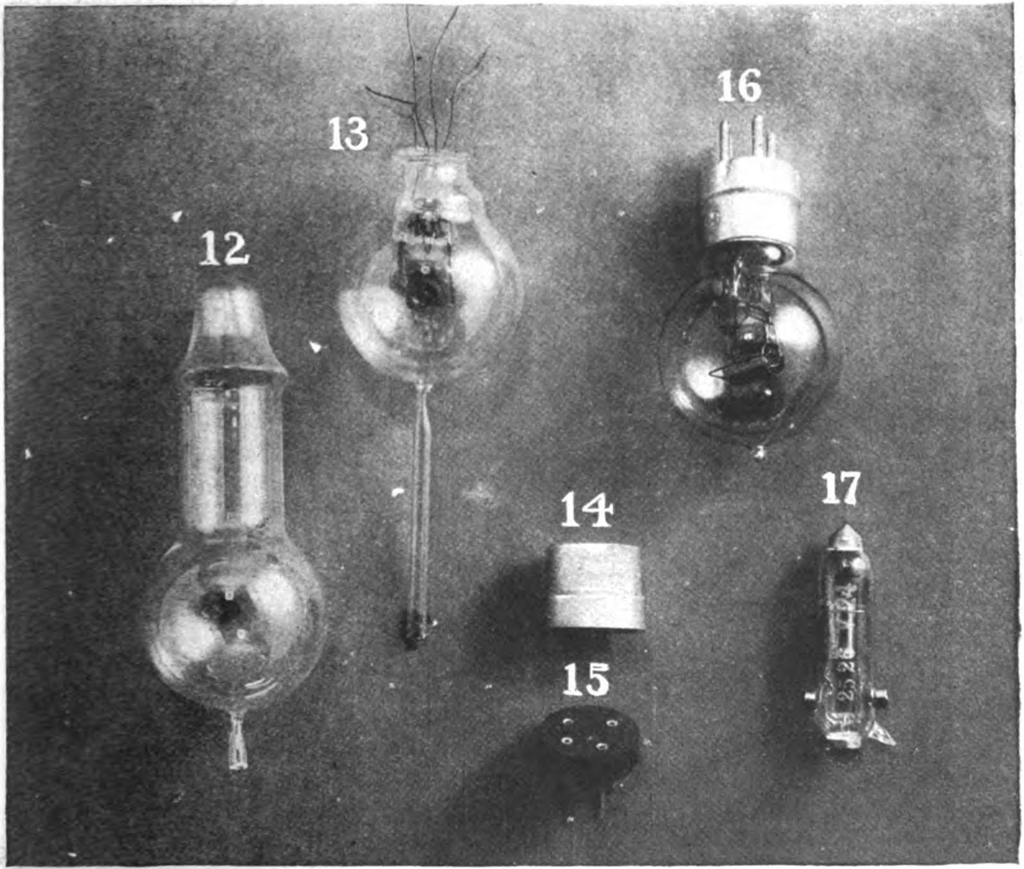
No. 13 shows internal assembly inserted in the bulb and the glass support, and the top end of the bulb welded into an airtight seal. The wire leads to the elements are left sticking out of the top of the bulb. The air is then exhausted through the glass tube attached to the bulb and when the proper vacuum has been obtained, this opening into the tube is also sealed.

No. 14 shows the metal casing, one of the two parts of which the base of the tube consists. This part is fashioned in a stamping machine which bends and cuts the part in a single operation.

No. 15 shows the other part, the contact piece. This is made of a moulded insulating material and the contacts are cast into it with their extremities projecting for the necessary connection with the lead-wires running to the plate, grid and filament inside the tube.

No. 16 shows the tube complete. The lead-wires have been soldered to the contact lugs of the base, and the base has been clamped into position, and—

No. 17 shows another type of vacuum tube, which is particularly adapted for radio frequency amplification; this tube is shown ready to be put into John Bull's British-made set.



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WITH THE INVENTORS

THIS *department—conducted by a patent attorney of wide experience in radio work—will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

Signaling on a .0000001 Meter Wavelength

Patent No. 1,412,385; Theodore W. Case, Scipio, New York.

THIS system of signaling utilizes electromagnetic or light waves of a length varying between .00001 centimeters and .0061 centimeters, a centimeter being a hundredth of a meter and 2.54 centimeters making an inch.

These waves are many times shorter than those which Marconi has recently used in his directive experiments and lectures and certainly much shorter than those of 200 meters assigned by the Secretary of Commerce for use by amateurs. As yet the government has not assigned these very short wavelengths in the electromagnetic spectrum or wavelength band.

For such electromagnetic waves ranging between .000038 centimeters and .000076 centimeters nature provides an anatomical receiver, the eye. The shorter wave produces the sensation of violet and the longer the sensation of red. Hence waves ranging in length as above and which may be seen are the light waves. Waves which are longer than the red and invisible are called infra-red waves and those which are shorter than the violet and also invisible are called ultra-violet waves.

The apparatus illustrated in Figure 1 transmits and receives waves which are visible, the light waves, as well as those which are invisible or beyond the grasp of the eye, the longer infra-red waves and the shorter ultra-violet.

The transmitter 14, which is merely a high powered searchlight, is the high frequency radiator of the system, radiating visible light waves of different lengths (white light) having an average frequency of around six hundred million cycles per second. The signal received however is not seen but heard. Hence the infra-red and ultra-violet waves or rays which cannot be seen may be utilized to affect the receiver and produce a signal. A blind man could use it, provided he could hear.

A characteristic of such very short electromagnetic waves is that they may be directed in straight lines and as a beam of light; the shorter the wave the easier it may be directively used. This is the reason that the short Hertzian waves can be made more directive than the longer ones, as shown by Marconi.

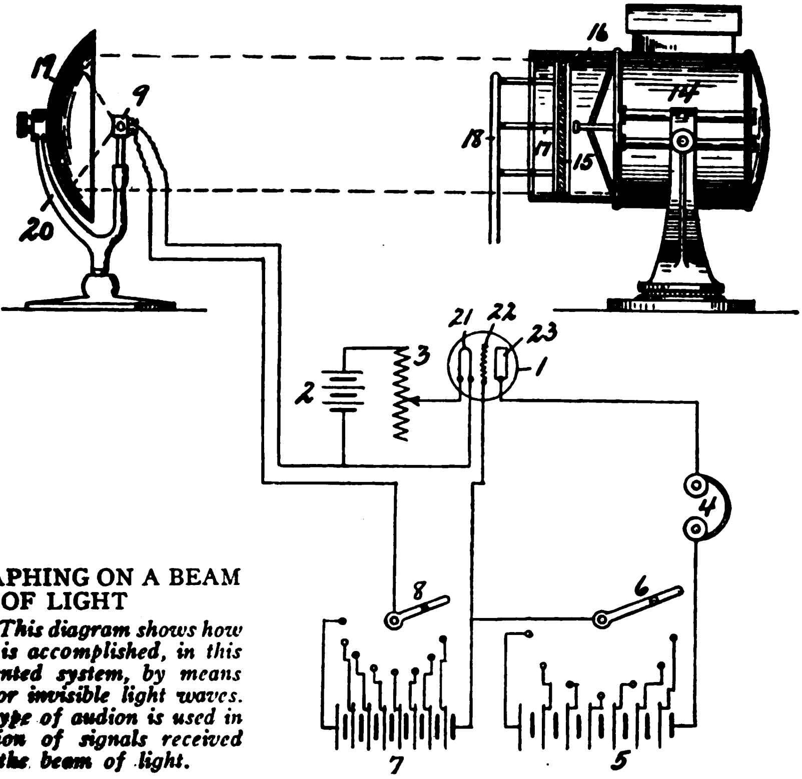
In the system shown in Figure 1 the waves, either visible or invisible, are propagated or transmitted in a sfraight line from the transmitter 14 and are received by the reflector 19, which we may call an aerial or collector. The waves are there reflected upon a member 9 which is in an electrical circuit. The member 9 has the curious property of varying the resistance of the circuit when these short waves strike it, causing current fluctuations which may be detected by means of the phones 4.

Various substances such as selenium or thalium sulphide may be employed as a light responsive device 9. The inventor states that he prefers to use a substance which is sensitive to the invisible rays of the spectrum, a compound of thalium and sulphur being particularly sensitive to the infra-red region of the spectrum while a compound of thalium and iodine is particularly sensitive to the ultra-violet region. By the use of either of these substances signals may be sent and received without detection by the naked eye or with ordinary optical instruments.

It is better to use a substance such as the thalium sulphur compound which is responsive to the infra-red or longer waves, as such waves may be transmitted to greater distances. As a proof of this take a well-known example, a sunset, when the sky is red with the dying day. Why is the sky red at sunset instead of being violet, blue or green? The physical explanation is that only the red rays reach the eye, the shorter waves being absorbed. The same principle applies to the Hertzian waves used in radio communication, the longer waves being transmitted greater distances than the shorter. Hence wavelengths of thousands of meters are employed for transatlantic communication.

Secrecy is possible in the use of this apparatus. For instance a screen 15 of the proper material, such as smoked glass, mounted across the extension 16 of the transmitter 14 will absorb the visible rays and allow only the invisible ultra-violet or infra-red rays to pass. Such invisible rays will however affect the member 9, varying the resistance of the circuit.

The circuit of the member 9 includes a special form of audion 1, having filament 21, grid 22 and plate 23. The plate and



TELEGRAPHING ON A BEAM OF LIGHT

FIGURE 1: *This diagram shows how telegraphy is accomplished, in this newly patented system, by means of visible or invisible light waves. A special type of audion is used in the reception of signals received over the beam of light.*

grid are connected in circuit with a battery 5 and a potential regulating switch 6, the phones 4 being in this circuit, while the grid and filament are connected in circuit with a battery 7 and a potential regulating switch 8, the member 9 being in this circuit. The filament is heated by battery 2 controlled by rheostat 3.

The inventor calls this audion a "pulsation generator." He states in his patent, as his discovery, that when the degree of vacuum in the bulb is properly regulated in accordance with the character of resistance 9 and of the voltage of the batteries, the current in the circuits will pulsate at a desired frequency, as, for instance, an audible frequency or a frequency bordering on audibility. So, upon variation of the resistance 9, a variation in the frequency is produced, audible in the telephone receivers 4.

The bulb 1 differs from the usual type of tube in having a gas therein, such as Argon, under a pressure which may vary from 1/10 to 5 millimeters of mercury, the ordinary tube being more highly exhausted. The bulb as above described is an essential element of the invention.

Signals may be transmitted by means of the opaque shutters 17 and actuating handle 18, which alternately shut off the waves and allow their propagation.

The invention has several advantages. In signaling between friendly ships in time of war the signal cannot be picked up by an enemy unless the latter happens to be located on the line between the transmitter and receiver. If a screen 15 is used there is nothing visible to show that signaling is being carried on. The invention may be adapted for harbor defense by locating the transmitter on one shore and the receiver on the opposite shore in a position to throw an invisible beam across and close to the water. The passage of a boat or even of a periscope of a submarine through the beam would cause a signal.

The circuit shown, being devoid of lumped inductances and capacities, is very sensitive to changes in resistance of the light responsible device 9, causing a variation in pitch of the note in phones.

Could not a similar apparatus be employed to transmit speech or music, utilizing these short electromagnetic waves, popularly called light waves? By inserting a microphone in the circuit of the transmitter, the light might be varied or modulated in accordance with the speech or music variations reproducing the original sound in the receiver. This may be a field for investigation, although it does not appear to be of great practical or remunerative value.

During the World War similar receivers were used by our forces to detect trench attacks. These receivers were operated by the heat radiations, which are similar waves, from the bodies of the enemy. The apparatus consisted of a substance, which varied in resistance when heat radiations struck it, in circuit with tube amplifiers. When the enemy approached, the radiations from the bodies of the soldiers operated the receiver, giving notice of the attack.

CHARLES H. KESLER.

Scientific Facts I Have Discovered About Radio

THAT *once you have become a radio fan you are a goner.*

THAT *Grandma is just as apt to get it as Willie.*

THAT *the shortest wave is the permanent one on the head.*

THAT *the less air in a vacuum tube, and the more in an inner, the farther you will carry.*

THAT *a boy can sit up till two o'clock in the morning receiving and never utter a word of complaint—*

BUT *if his father tells him to stay up and close the furnace—then what an interference!*

HOMER CROY

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our *subscription list.* A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.

QUESTION: Please give me a hook-up for using three honeycomb coils or spiderweb coils on a crystal detector. In your July issue of POPULAR RADIO you showed the hook-up for an audion set, but I would like to know what to do with the two extra leads from the tickler coil.

C. M. CONNEL

ANSWER: Spiderweb or honeycomb coils may be used with a crystal detector in the hook-up shown in Figure 1. The tickler coil will be dispensed with. If you have a three coil mounting, leave out the connections for the third coil. Two variable condensers are used for tuning, a .001 mfd. in the antenna circuit and a .0005 mfd. in the secondary circuit. The coupling is varied as usual by changing the relative positions of the two coils.

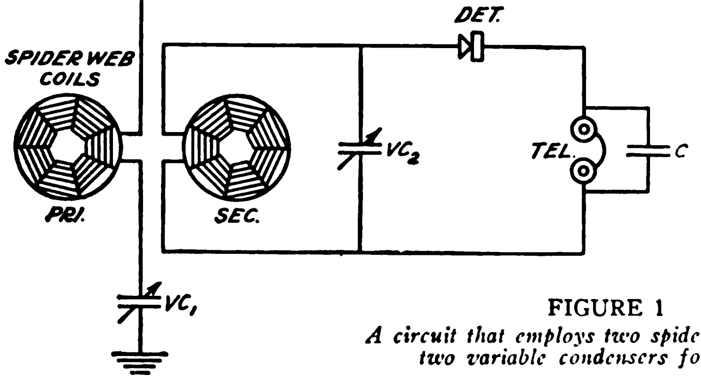
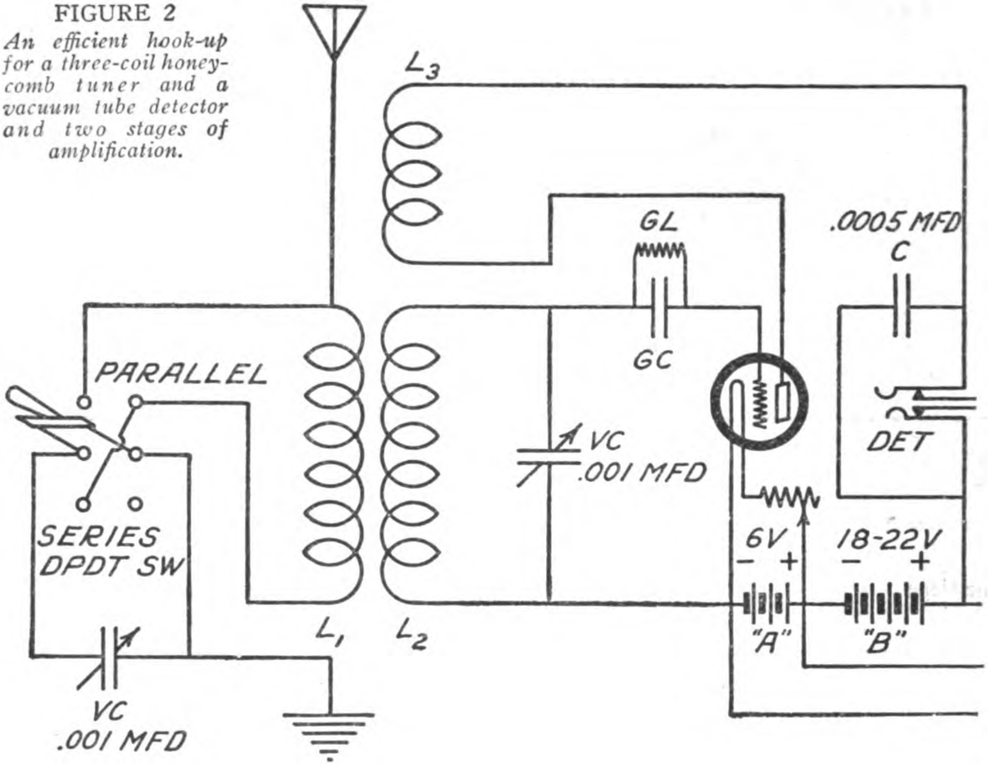


FIGURE 1

A circuit that employs two spiderweb coils and two variable condensers for tuning.

FIGURE 2
An efficient hook-up for a three-coil honeycomb tuner and a vacuum tube detector and two stages of amplification.



Question: I have built a three tube regenerative set, using two variometers, variocoupler, variable condenser, one detector UV-200, and two stages of amplification. I get Cleveland on both stages but am unable to reach out for long distance. I recently heard Detroit, but could not get it clearly; I could hear a whistle, but it did not sound much like music. Can you tell me my trouble? I am anxious to get long distance, especially Detroit and Pittsburgh.

R. P. Robinson

Answer: Your description of the symptoms are so meagre that it is hard to diagnose your trouble. Is your antenna efficient? It should be approximately 100 feet long, of one or two wires. What you say about the noise you hear would lead us to suspect that you are not familiar with the tuning of a regenerative set, and are using too much regeneration, thus getting the whistle. Consult the article by Mr. Hogan in the November issue of this magazine. Are you sure that you have the correct "B" battery voltage on your detector tube? The UV-200 is critical as to plate potential and this may be part of your trouble. You will find the correct potential to lie somewhere between 16½ and 18 volts.

* * *

Question: Please give me a hook-up for a detector and two-stage audio frequency amplifier, using honeycomb coils, with jacks and plugs for each tube. A series-parallel switch for the primary condenser should be included in the circuit, for changing the wavelength range.

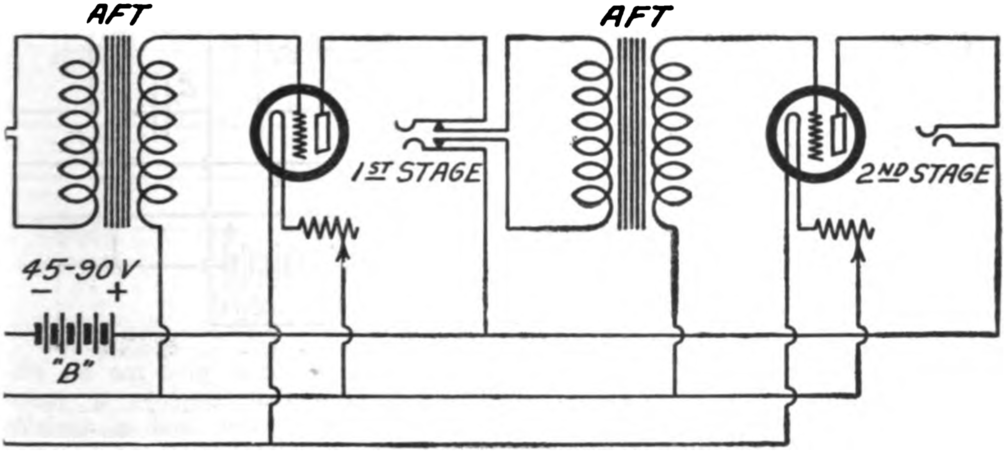
A. F. Rockefeller

Answer: In Figure 2 is shown a circuit that will be found efficient and easy to tune; it includes the apparatus that you wish to use. A double-pole double-throw switch is used to connect the primary condenser in series or parallel, as shown in the diagram. The coils L1, L2, L3 are honeycomb coils and are fitted to a standard 3-coil mounting. The primary and secondary circuits are tuned by means of the variable condensers and the coupling. The regenerative action is controlled by means of the coupling between the secondary coil L2, and the tickler coil L3. By using coils of different values, either high waves or low waves may be efficiently received.

Question: I have built a crystal set and also a tube receiver. With the detector alone I have received over a hundred miles. I am interested in the new Armstrong circuit, described in detail in the September issue of Popular Radio. Many friends among the radio amateurs and merchants of San Francisco tell me that the right "dope" concerning this circuit has not been made public by Armstrong; also that few of the sets built by amateurs work successfully. Your article created a great deal of excitement in this vicinity; many of the fans want to start work on such a set immediately. But the radio experts advise us to wait before investing in the necessary materials. Please advise me what to do.

Dixon Chubbuck

Answer: When Major Armstrong read his paper before the Institute of Radio Engineers and the Radio Club of America he did not hold back any information in regard to the super-regenerative circuit; in fact, he made his talk very plain both as to the construction and operation, even going so far as to recommend the best circuits to use, and specifying the kind and sizes of all the important parts. The modified circuit shown in *Popular Radio* for September gives excellent results if properly constructed and tuned, and if the tubes used are suited for the purpose. We have received many letters that report the wonderful results obtained from sets built in accordance with our instructions. In the hook-up department of our November issue were published a number of hints which should help the man contemplating building a "super" set. There is no doubt but that improvements will be made in adapting the principles of super-regeneration to the uses of the amateur, but why not "get in" on the development work yourself? This is one of the greatest experiences that the amateur can possibly have. We advise you and your friends to begin experimenting with the set now; there is no doubt but that you will get the set working well if you follow the directions.



Question: The filament of my Moorhead detector tube burns all right, but I hear nothing on the phones; when I place a good tube in the socket, the set works O. K. Is it paralyzed or is there a loose connection inside of the tube? This trouble has exasperated me, as I have tried new "B" batteries and have experimented for weeks, trying to find out what was wrong. Can you advise me what it is?

C. T. Busby

Answer: Any one of the following faults could be the matter with your tube or circuit:

1—The prongs on the bottom of the tube may be short in length, so that proper connection is not made with the contacts of the socket;

2—The prongs may be dirty, causing the same trouble;

3—There may be a loose connection in the base of the tube;

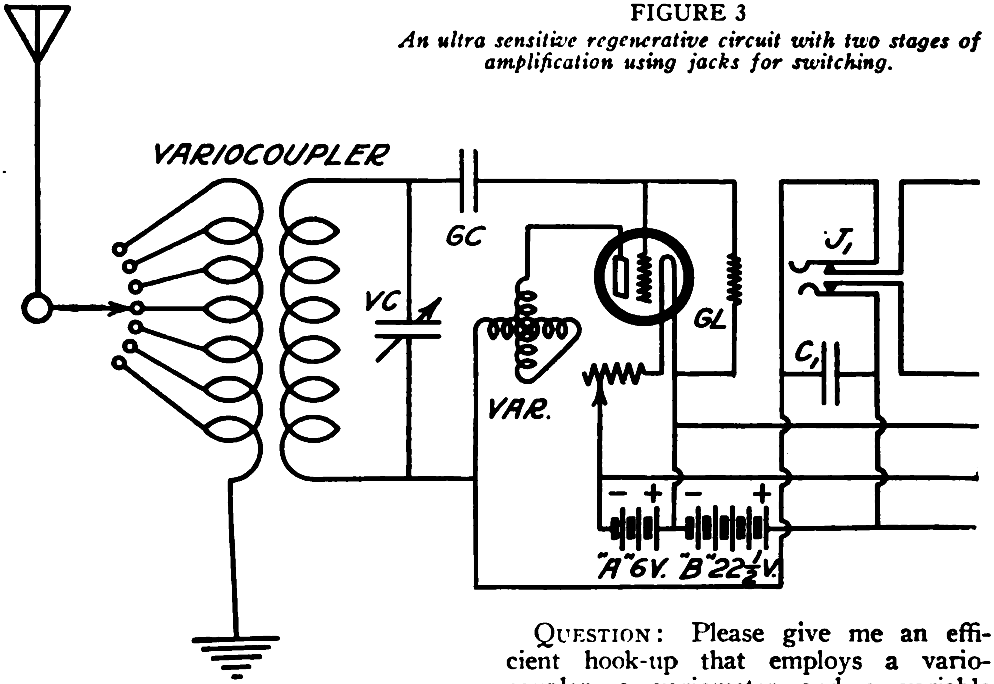
4—The filament may be leaning against the grid of the tube;

5—You may be using too high a plate voltage on the tube.

It is likely that you will find that one of the above points covers your trouble. If it is any one of them (except the fourth) you can remedy it yourself, but if it is the fourth, the tube is defective and you had better send it back to the manufacturer.

FIGURE 3

An ultra sensitive regenerative circuit with two stages of amplification using jacks for switching.



QUESTION: I have a panel of walnut (black) ¼ inch thick, which is fifty years old and thoroughly cured and dried. Can I use this in place of the Bakelite usually used? Also how do I connect aluminum sheets behind the panel for shielding the variocoupler and variometers? I have 1/16 inch lead sheet; will this do instead?

E. W. LONOVAN

ANSWER: The walnut panel will be suitable if well dried. The aluminum or lead sheet may be cut the size of the panel and screwed or glued to it. Care must be used so that the lead sheet does not touch or make contact with the instruments that are mounted on the panel, however. Cut out small circles in the sheet where the instruments are fastened or where binding posts pass through the panel. If glue is used be sure it does not spread in between the instruments, as this would cause leakage. The sheet should be connected to the ground binding posts.

* * *

QUESTION: Is the crystal detector as good as the vacuum tube for short distances?

HENRY E. WADE

ANSWER: The crystal is suitable as a detector up to 25 miles, but not as efficient as the vacuum tube.

QUESTION: Please give me an efficient hook-up that employs a variocoupler, a variometer and a variable condenser with detector and two stages of audio frequency amplification.

W. F. HAMMER

ANSWER: In Figure 3 you will find the information you require. The circuit there shown is arranged so that one, two, or three tubes may be used, as necessitated by the strength of signal required, by plugging into the correct jack. The small fixed condenser connected across the first jack is used to pass the radio frequency currents around the telephones or the primary winding of the amplifying transformer in the regenerative circuit.

* * *

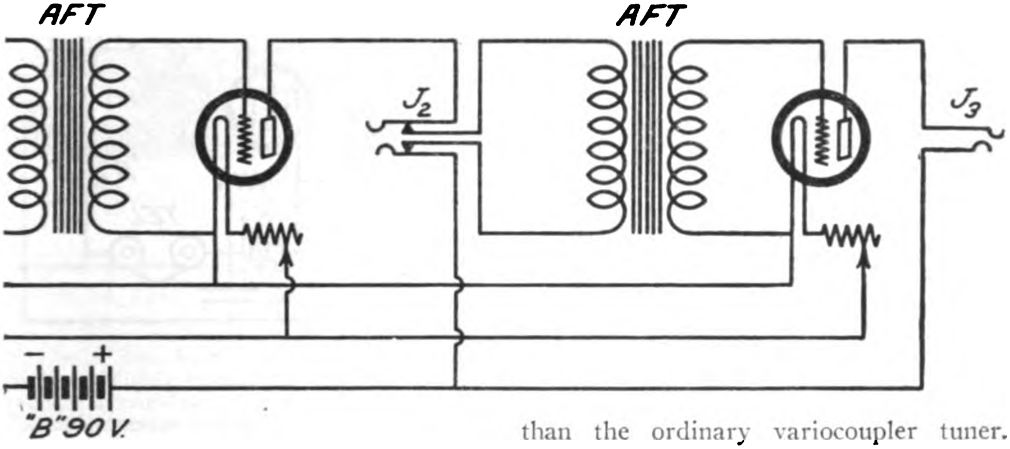
QUESTION: How may I make moisture-proof some wood that I intend to use for the supports on the ends of a loose-coupler that I am building?

C. S.

ANSWER: You may drive out all moisture by placing the wood in a bath of melted paraffine, which is kept at a temperature above 100 degrees centigrade. Keep the wood in the paraffine until all bubbling ceases; at that point all the moisture will have been boiled out of it. Then hang the pieces of wood up to dry in a cool place. When they are cooled off sufficiently they will be ready to use without fear of leakage due to moisture. It is not good practice to use parrafine on coils, however.

QUESTION: Does the WD11 1½ volt vacuum tube work as an amplifier or can it be used only as a detector? What "B" battery voltage should be used with it if it will work as an amplifier?

PAUL A. GERHARDT



ANSWER: This tube can be used as an amplifier with good results. The "B" battery potential should be about 45 volts for this purpose, although the tube will stand as much as 100 volts with slight increase of signal strength. The "A" battery required is one dry cell.

* * *

QUESTION: With a Remler No. 400 three-coil mounting, how many turns should the QSA inductances have, to tune to 360 meters, with the ordinary tickler feedback regenerative circuit? I want to use the plug-mounted coils rather than the ordinary variocoupler tuner.

F. E. SMITH

ANSWER: The following coils should be suitable for your purpose:

Primary; 35 turns
Secondary; 50 turns
Tickler; 50 or 75 turns

* * *

QUESTION: Kindly give me a hook-up for a variocoupler, a condenser (variable), a small condenser (fixed), a grid-leak-condenser, vacuum tube, phones and "A" and "B" batteries.

E. PRICE

ANSWER: The circuit shown in Figure 4 is efficient and easily put together.

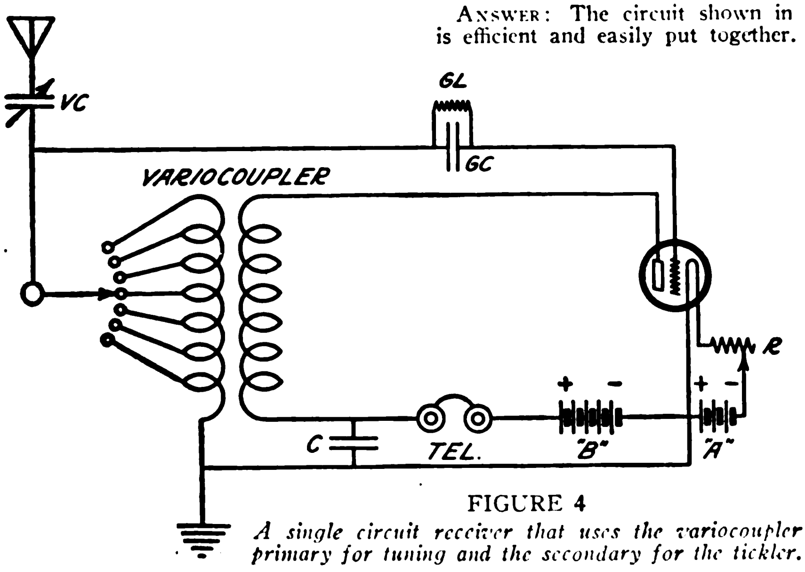
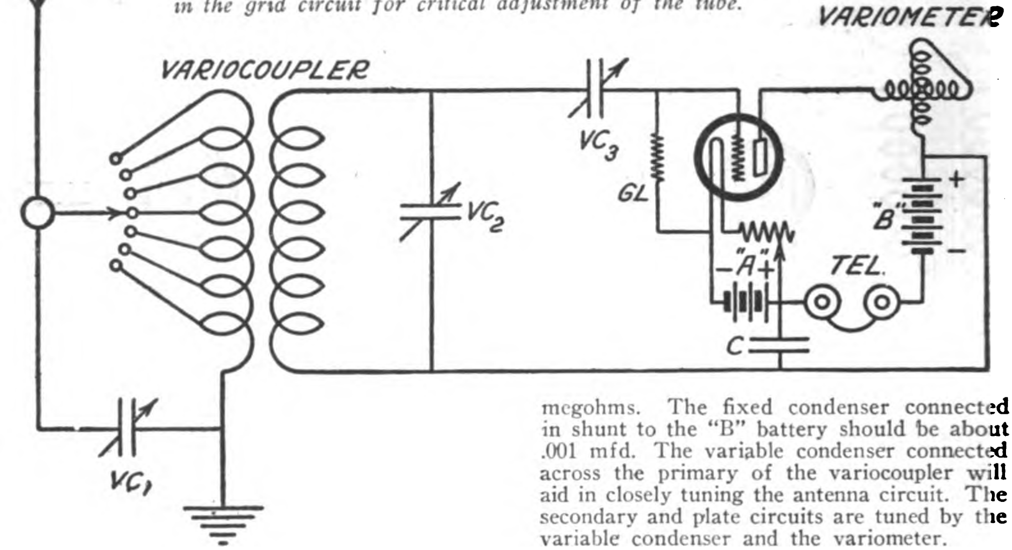


FIGURE 4

A single circuit receiver that uses the variocoupler primary for tuning and the secondary for the tickler.

FIGURE 5

A simple regenerative circuit with a variable condenser used in the grid circuit for critical adjustment of the tube.



QUESTION: Kindly give me a good circuit that employs three .0005 mfd. variable condensers and a variometer, to be used with an audion detector.

THOMAS FUNK

ANSWER: In Figure 5 is shown a regenerative circuit which should give you good results.

It will be noticed that the grid condenser is a variable condenser and the capacity can be varied until the best results are obtained. The grid leak should be about 1 or 2 megohms. The fixed condenser connected in shunt to the "B" battery should be about .001 mfd. The variable condenser connected across the primary of the variocoupler will aid in closely tuning the antenna circuit. The secondary and plate circuits are tuned by the variable condenser and the variometer.

* * *

QUESTION: Please give me a diagram showing a hook-up for one stage of radio frequency amplification on a two-circuit crystal receiver.

HARRY R. SCHULTZ

ANSWER: The circuit is shown in Figure 6. The parts required are the following:

2 variable condensers, .001 mfd.
1 tapped tuning coil
1 filament rheostat
1 potentiometer, 200 ohms
1 loose coupler or variocoupler
1 crystal detector
1 pair head telephones
1 fixed telephone condenser
"A" and "B" batteries

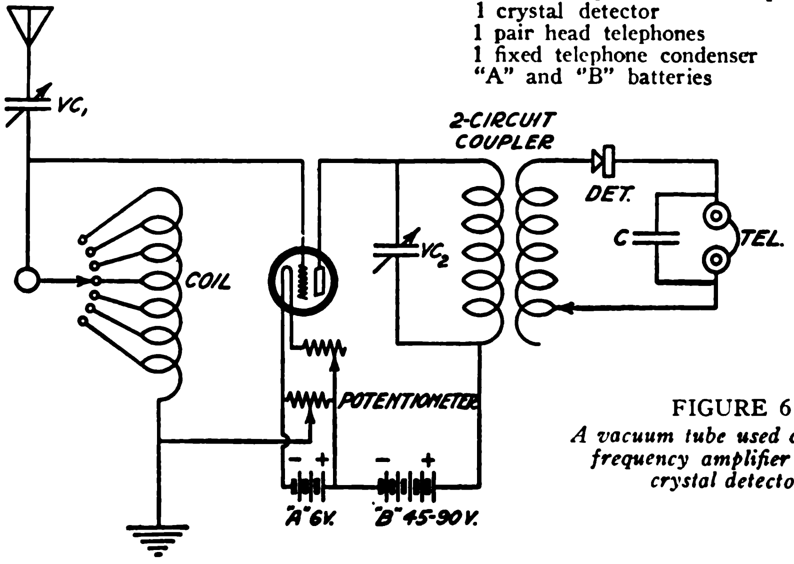


FIGURE 6

A vacuum tube used as a radio frequency amplifier with a crystal detector.

BROADCASTS

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

86,000,000 Square Miles of Church Service

A RECENTLY-COMPLETED study of the broadcasting situation by the National Radio Chamber of Commerce reveals that there are 83 radio stations in the United States that are broadcasting religious services, and that they cover a territory that represents 65.2 per cent of the area of the United States.

* * *

The Metronome as a Solo Instrument

SOME of the broadcasting stations have adopted a clever scheme for letting listeners in know that they are still tuned in during the brief intervals of silence between numbers on the programs. As soon as a number is concluded, a metronome—a small ticking instrument used by pupils of music for keeping the tempo—is set in motion until the next announcement is made. This ticking keeps the radio fan informed that he is still "on the ether."

* * *

A Chance for American Fans to Hear Paris

IT is not unlikely that by the time this issue of POPULAR RADIO reaches its readers some of them will have picked up radio telephone messages from the Eiffel Tower, which recently began transmitting at 5:10 A.M., 7:20 A.M. and 11:15 A.M., Greenwich mean time. It was announced that the power would be increased shortly.

* * *

Jurors Are Warned Against Radio

JURORS, who have long been admonished by judges not to read newspaper accounts of the law cases on which they are engaged, are now threatened with another hardship. Prospective jurors in a Pacific coast murder trial have been warned not even to listen in to radio broadcast accounts of the case.

* * *

Broadcasting Historic Chimes

THE music of the carillan of Malines Cathedral in Belgium, the seat of Cardinal Mercier, is now being broadcast from a radio outfit installed in the belfry. Radio fans in Belgium and in the surrounding countries may now listen to the music of this famed battery of bells.

A Ship's Set Spans the Pacific

EACH morning on a recent voyage across the Pacific to San Francisco the steamer *Matsonia* held radio communication with KHK, the radio station at Apia, British Samoa. The last talk took place at a distance of 4,050 miles, at 8:30 o'clock in the morning the day before the steamer reached port. The radiophone work was done on a 550-meter wavelength.

* * *

An Aerial 700 Yards Underground

TESTS recently made in Birmingham, England, in transmitting messages from the interior of the Baggeridge Colliery to the pit mouth, proved of value to experimenters. From a depth of more than a third of a mile signals were clearly received, but the telephony was weak, due, it was conjectured, to the absorbing effect on the radio waves of the carbon particles in suspension in the air underground.

* * *

The New "Radio Letter"

A PLAN that will undoubtedly lead to closer ties between the United States and certain foreign countries has just been inaugurated by the Radio Corporation of America, which has established a rate of six cents a word for "radio letters" to England and Germany. At the present any person in any city or town in the United States can write a letter to a person in London or Germany with the envelope marked "Radio Letter," addressed to the Radio Corporation of America in New York. The message will be sent direct by radio to the Carnarvon, Wales, receiving station, which is in direct connection with London. If the letter is for a point in Germany, the message is flashed to Nauen, which is connected by special wires with the Post Office in Berlin.

Radio letters are transmitted across the ocean on Saturdays and Sundays and are delivered the following Monday.

* * *

Long-Distance Dancing by Radio

A RADIO fan, Charles William Taussig, recently gave a dance at his home in New York, for which the music was supplied by an orchestra playing in Chicago. The music is reported to have come, not spasmodically, as is frequently the case in long-distance reception with low-power stations, but continuously loud for more than two hours. No outside aerial wires were used, just a three-foot loop antenna.

* * *

Radio Set Makes Its Debut in a Will

THE first recorded instance of a radio receiving set being specified in a will was revealed when the will of James J. O'Heir was probated in New York. In it he bequeathed "radio sets and tools, valued at $500," to William Watson.

* * *

Will We Pick Up S.O.S. Calls from Air Ships?

THE time is coming near when every aircraft will be required by law to carry radio equipment. At the first public session of the International Commission for Aerial Navigation it was agreed that all aircraft engaged in public transportation must carry a set; at present the law applies only to aircraft that carry ten or more persons.

* * *

Why There Is So Much Interference

"THERE are entirely too many broadcasting stations operating in this country," is the gist of a report by the National Radio Chamber of Commerce. From other sources it is learned that the number is close to 600. A little figuring reveals that these stations cover an area of 179,500,000 square miles—which is 135.2 per cent of the area of the country. In other words, while some portions of the country are not covered by broadcasting service, other sections are covered by too much.

Radio Gives First Aid to Land Wires

FOR the first time in history radio telegraphy was utilized last month to transmit a full press association news report across the Continent. Due to severe sleet, snow and wind storms in the Rocky Mountain region and the crippled service on land lines, the International News Service transmitted a full election service from New York to San Francisco by radio. Messages were transmitted efficiently to the newspaper offices in San Francisco and came through as fast as those obtained over land lines under ordinary conditions.

* * *

Are Marriages by Radio Legal?

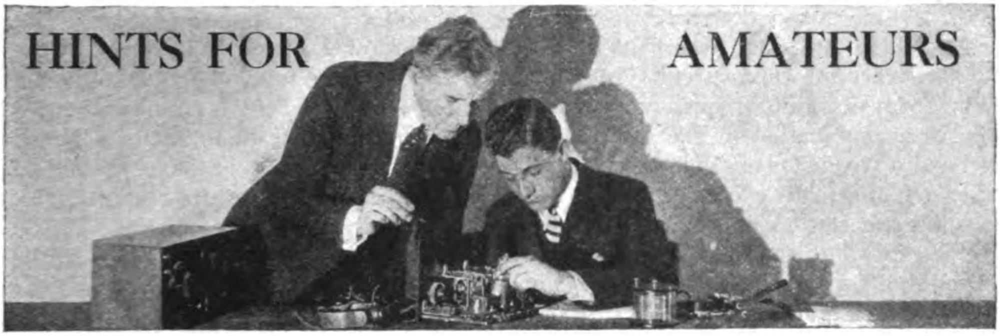
THE next time you contemplate getting married by radio, find out whether or not the laws of your State accept such a marriage as legal. Attorney-General Charles D. Newton has just announced that the laws of New York State do not.

"I am of the opinion," he ruled, "that any attempt by a clergyman or magistrate to perform a marriage ceremony without being actually present with the contracting parties, witness or witnesses, would not comply with the mandate of the statutes of this State. The words, 'in the presence,' as contained in the domestic relation law, mean an actual and not a constructive presence. It is as essential that the witnesses and person officiating should be immediately at hand as it is that the contracting parties to the marriage should be in view of each other. The importance and sanctity of the marriage relation require a strict rather than a liberal interpretation of the safeguards which the Legislature has set up in the State."

© Harris & Ewing

PUTTING THE SHIP'S ORCHESTRA IN THE RECEIVER'S HANDS

When the Washington Choral Society of Washington, D. C., chartered the Steamer "St. John" for an excursion trip it saved the money that might have gone to hired musicians and used instead a sensitive receiver that worked on a loop antenna, by means of radio and audio frequency amplifiers. And the party danced to music furnished by WGY, WSB, NOF and WMU.



HINTS FOR AMATEURS

In setting up a radio station it will be well to remember not to run the antenna lead-in wire and the ground wire close to each other or parallel to each other for any distance, as this will materially decrease the efficiency of the receiving or transmitting sets attached thereto.

* * *

When you attach more than one pair of receivers to your receiving set, be sure that the receivers have the same value of resistance and are connected in parallel. For instance; if the operator uses a pair of 3,000 ohm telephones, and wants another pair so that a second person may listen in at the same time, he should purchase telephones of the same resistance (3,000 ohms) and connect them in parallel. If a pair of 3.000 ohm receivers are connected in parallel with a pair of 2,000 ohm receivers, the lower resistance pair will take most of the current and the higher resistance pair will not respond with their regular strength.

When telephones of unequal resistance are used, it is usually better to connect them in series.

* * *

Many amateurs who build their own receiving apparatus have experienced this peculiar trouble; when listening to distant stations on a single detector tube they receive signals fairly well, but when they turn on their amplifiers to increase the strength of the signals they find that the set refuses to oscillate and they lose the signals altogether; often they are not able to pick them up again while the amplifiers are in use. This is particularly true in the case of C. W. signals.

This trouble may easily be remedied by connecting a fixed telephone condenser across the primary of the first amplifying transformer. The function of this condenser (called a "bypass" condenser) is to pass the radio frequency currents flowing in the plate circuit of the first tube around the high impedence windings of the amplifying transformer and thus enable the first tube to oscillate properly. This simple expedient is usually neglected, but it is a really efficient addition to any amplifier set not now so equipped. When only one tube is used, however, the capacity between the two wires in the telephone cords, which are in the plate circuit, is usually enough to act as a substitute for this condenser.

* * *

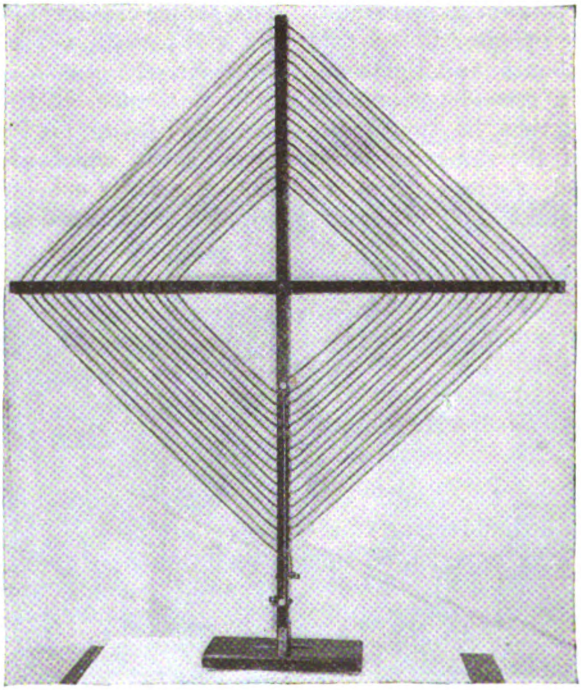
Vacuum tubes sometimes vary in their characteristics, and often the results obtained in a radio receiving set can be improved by placing the tubes in different places in a set. Of course a soft detector tube cannot be used successfully as an amplifier with a high-plate voltage, but where three hard tubes are used in a regenerative set for both detection and amplification, it would be well for the operator to switch the tubes around in their sockets—trying first one tube as detector and the others as amplifiers. Then the tubes should be moved up into other positions, and the results compared. A number of combinations can thus be obtained with a regenerative set and a two-stage audio frequency amplifier.

THE loop antenna, when used with suitable vacuum tube circuits in which some form of radio frequency amplification, or a combination of radio frequency and audio frequency amplification is used, will be found to be efficient and will help to eliminate static and directional interference to a large extent.

For those who have such a set or who contemplate building or purchasing one, the question sometimes arises as to whether the wire used or contemplated for use on the loop should be bare copper wire or insulated, whether it should be solid, stranded or tubular.

After careful tests on all types of wire or cable for this purpose it has been found that the best cable for this purpose is a tubular hollow-center cable. This cable is made of a number of flat ribbons of pure copper, braided into a tubular shape of approximately a quarter inch in diameter. Of course, it has been already proved that the tubular shaped conductors are the most efficient for radio frequency currents. The results obtained from a conductor of this type have proved far in advance of the results obtained from any other type of cable or wire.

Another feature which makes this cable particularly adaptable for use on a loop is its extremely light weight, which prevents the loops from becoming top-heavy. A square-spiral loop of from seven to fifteen turns, spaced ½ inch between turns with the outside turn about two feet square, has been found satisfactory for use below 450 meters. If the loop is made of tubular braided wire, the slots in the supports will have to be spaced about ¾ inch from center to center to obtain a spacing of ½ inch. A loop of this type is shown in the illustration below.



Brown Bros.

A LOOP ANTENNA THAT YOU CAN MAKE AT HOME

This loop consists of 15 turns of tubular braided cable wound on three-foot hardwood sticks that have been slotted to take the cable. The turns are spaced ¾ inch, center to center. Fahnstock clips are connected to every other turn of wire; these are mounted on the back of the vertical stick and are used to select the proper number of turns of cable.

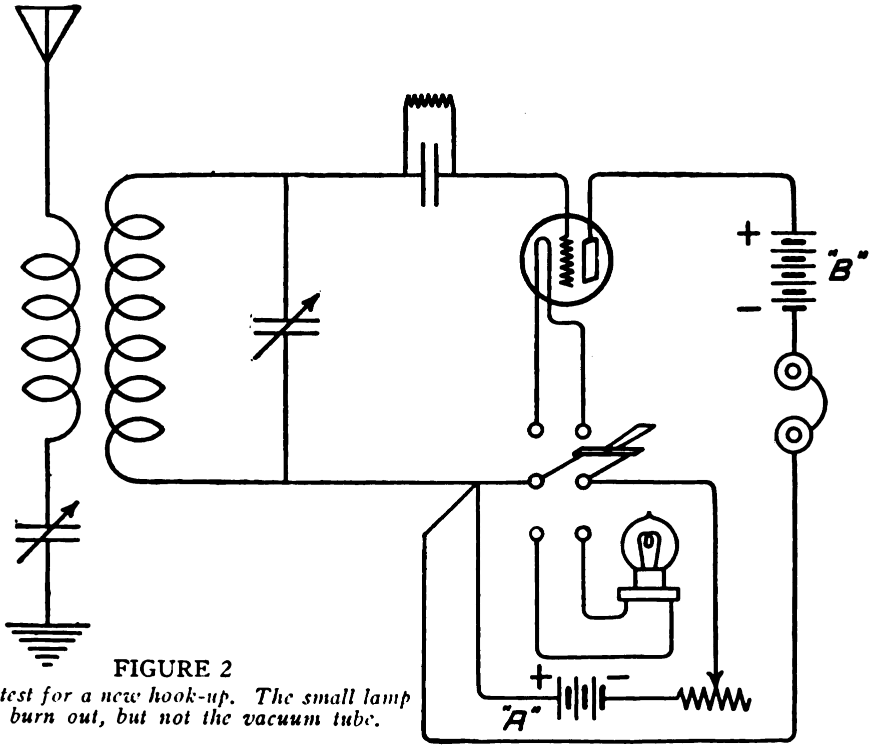


FIGURE 2
A safe test for a new hook-up. The small lamp may burn out, but not the vacuum tube.

For the experimenter who is trying different receiving circuits and who wants to protect his audion tube, the following suggestion will be of value and may at some future time prevent the blowing out of the tube on account of some unforeseen accident.

The two wires leading to the filament are brought to a double throw switch. At the other end of the switch a 6-volt lamp is connected. The blades of the switch are connected to the battery. When the experimenter wants to try some other hook-up, he makes the change with the battery connected to the 6-volt lamp; then when the change is made he knows if the lamp burns with the correct brilliancy that the wiring is not short-circuited or that the "B" battery is not connected across the filament. If the connection should be wrong and the 6-volt lamp is burned out, he has protected the audion from the same fate. The 6-volt lamp costs only about 30 cents; the audion costs $5.00 or more. (See Figure 2.)

Bakelite panels may be given a dull satin finish by rubbing with smooth sandpaper and a light oil. Rub the surface in one direction, back and forth, but not in circles. Keep on rubbing until the surface is perfectly smooth and all the little indentations are removed; then wipe off with a dry clean cloth and the panel for the new set will have the same finish as the large panels used in commercial radio apparatus. Never use water to clean bakelite panels; use oil.

* * *

In Testing out a variometer to determine if there is a loose connection in the leads joining the rotor to the stator windings, connect a buzzer and a battery in series with the variometer; the buzzer should buzz steadily. If upon turning the knob of the variometer the buzzer works intermittently, you will know there is a poor connection, and will be able to make repairs without tearing the rest of the set apart while looking for faults elsewhere.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Should Broadcasting Stations "Lay Off" Occasionally?

THE idea put forward by the following correspondent is not new. The question is whether or not radio fans approve of it in sufficient numbers to influence the big stations to keep silent once in a while. What do you think?

I believe that radio enthusiasts with small sets and long-range equipment will join with me in this suggestion that the management of broadcasting stations, by localities, arrange with each other and agree upon a one-night layoff each week for the following reasons:

First—It will give operators and artists the equivalent of a Sunday rest.

Second—It will permit a tryout of receiving stations in any locality to determine their range and the variety of adjustments necessary to pick up out-of-town sending stations.

I live in Chicago almost in the shadow of several large antennas. With great care I have built up an elaborate 5-tube set in anticipation of some opportunity to try it out during the winter evening hours. But with two high-powered broadcasting stations and half a dozen smaller sets waiting like hawks for their turn at the air or even sometimes doubling their dissimilar wave bands, how can a chap expect to get out of his own backyard, so to speak? I like to go visiting occasionally. I would like to hear someone else besides homefolks.

Recently, in a thirty-minute period of relief from local disturbances during the early evening broadcasting hour, I was able to clearly tune in just six stations: Detroit, Louisville, Kansas City, Waco, Oklahoma City, Denver, Schenectady, and that popular Southern station, *The Atlanta Journal.* All of these stations furnished a wide variety of program readily available for selection, but all too quickly spoiled by a local carrier wave. I experienced more real thrills in that thirty minutes than during the whole of the rest of the week. Pleading for a night off, and, as a basis for an agreement, I suggest that the New England States and New York City close up absolutely tight on Monday night of each week between the hours of 7 P. M. and 10 P. M., local time; that the Pittsburgh and the Buffalo longitude close Tuesday nights; that Detroit, Chicago, Indianapolis, etc., close Wednesday nights; that St. Louis, Kansas City, Omaha, etc., close Thursday nights; that Denver and that longitude close Friday nights; and that the Pacific Coast observe Saturday nights—each area to observe the same hours—7 to 10 P. M.—in its own local time.

WM. P. BEAR

* * *

400 Miles for a Dollar

OF the many reports that have reached this magazine concerning the exploits of home-made crystal sets, this one from Indianapolis holds the record for low cost for the mileage received:

My wife and I have made several crystal sets, but we like the last one we made the best. This set consists of a ten-tap coil, crystal and phones, no condenser. It can be made for less than a dollar.

With this set we have been getting the following stations: WGY, KDKA, WLW, WOC, WHAS, WSB, WGM, WOAI, WWJ, KYW, NOF, and the *Kansas City Star.* One tap gives up 360, one 400, one 485, and the others the code stations. When on the 360 tap, the code stations do not interfere.

We are using a single wire aerial 135 feet long, 25 feet high, No. 9 solid copper, pointed northwest.

Our loudspeaker is made from an old honk! honk! horn, fixed so that we can clamp our receivers on it.

EARL C. THOMPSON

A Half-Inch Copper Strip Strengthens My Signals

ARE you troubled with "weak signals?" Maybe the experience of 2AWW in reducing the resistance in his ground connections will help you to overcome this trouble:

In most of the installations which I have seen the earth connection is taken from the nearest pipe available to the set. If you should trace the lead from the ground post of your receiver to the point where it enters the earth and see the indirect route, with all the couplings and elbows in the pipe, you would realize that all this resistance must necessarily cause weak signals.

The earth connection should be a conductor of high conductivity and as direct as possible to the earth; a half-inch copper strip will serve the purpose very well. This should be connected to as much surface in the earth as it is possible to obtain. An old boiler buried about four feet deep and clamped around tight with copper strip and soldered in three or four places will give good results. If the strip is connected to the street side of the water pipe and any gas, electric or steam pipe is connected with it (thus adding more surface), this may also be used with good results. If the station is situated in the mountains or some dry place where a good damp ground cannot be obtained, a capacity ground (counterpoise) is recommended.

A counterpoise, too, requires as much surface as possible. It should consist of one thousand or more feet of seven strand No. 22 wire or No. 14 hard-drawn wire and placed directly under the aerial about seven feet high, well insulated from the ground. This type of capacity ground has proven successful around the armatures for both transmission and reception.

If care is exercised in running a ground system instead of twisting a wire around a pipe and taking it for granted that everything is O. K., the received signals freed from the burden of resistance in their path will show a considerable increase in strength.

George Johnson (2 AWW)

Sport-Commercial

A GLIMPSE INTO THE WARFARE OF THE FUTURE

A significant demonstration has been made in Washington of the uses of radio for controlling the movements of a number of tanks during experimental maneuvers. In these tests the commanding officer maintained personal communication with the operator of each unit. It is probable that tanks will eventually be placed under direct radio control, as has already been done with working models.

The Burial of the Loop Antenna

SCIENTISTS have been telling us that the familiar aerial, rising like a mast above the home of the radio fan, is doomed. Now they are burying the more modern loop antenna also—not, however, because it is obsolete, but because placing it underground increases its efficiency, as Mr. Dodge points out:

During the World War the United States Signal Corps and the Bureau of Standards made an exhaustive study of the properties of the loop aerial, and it is chiefly due to their development work that the loop aerial is used so much today. In their research work the Bureau of Standards discovered that the loop antenna was the best kind of aerial for diminishing atmospheric disturbances, or static, which sometimes renders a receiving station almost useless.

One successful method of eliminating these strays is the use of buried loops. In this method of lessening static a movable loop aerial is suspended in an underground room. When this is done the receiving set must also be placed in the underground room.

A regular aerial may be used with the underground loop and this is connected to the primary of the receiving transformer which is connected to the earth. The secondary of the instrument is connected to the rest of the apparatus with the underground loop hooked up in series with one side of this circuit. It is interesting to note that the loops may be under water as well as under land, the liquid acting as a shield and having the same effect as the earth.

Underwood & Underwood

A SHOPPING-BAG RADIO SET

Compact as this outfit is, it is a cumbersome piece of work in comparison to the pocket-set that we will some day carry about with us as commonly as we now carry watches.

Not only may messages be received by means of the loops, but signals have been transmitted up to certain distances. With an ordinary antenna the transmitted waves are materially affected by surrounding objects, such as trees, mountains, buildings. This distorts the static or magnetic field, or both, and causes a variation of the determined direction from the true direction. The shielded underground loop greatly reduces the error resulting from this cause.

There is a great field for amateur experimentation in the use of buried aerials. Without going to the trouble of erecting a loop aerial, the interested amateur may simply dig a trench about a foot deep and lay some number fourteen insulated copper wire in the excavation and lead one end of the wire to the receiver. Signals with great directional effect can be heard with an antenna of this sort. Of course, in preparing for reception from a certain station, the underground wire should be pointed in that direction, that is, it should be laid out in a straight line with the lead-in wire at the end pointing to the station to be received.

Not only may messages be copied with insulated wire, but experiments prove that *bare* wire can be used. This seems astounding because in this case the wire is grounded, but still radio waves can be detected; and little difficulty should be experienced in picking up signals up to one hundred miles, employing one audion tube.

In the summer time when the static is bad, excellent results may be obtained in receiving the long-distance, high-powered land stations by making use of the directional property of the underground aerial or loop with a two- or three-step amplifier. It is much simpler to operate the underground loop than the buried aerial, as it is easily rotated on a pivot to the proper direction for maximum reception; in the case of the buried aerial the amateur has to constantly change the direction of the wire to secure the proper intensity of the signal.

Of all the different types of aerials used, the loop offers the greatest field for amateur research work. In time to come, when radio will possibly be developed so that two persons may converse by voice and not be overheard by anyone, the loop aerial will undoubtedly play an important part. The loops are being used more and more every day, especially by persons living in apartments in the city where overhead wires are "taboo." There may come a time when all amateur and commercial aerials will be constructed beneath the earth, with no exposed wires at all.

HERBERT WARREN DODGE

From a photograph made for POPULAR RADIO

HE MADE A "MISTAKE" THAT LED TO A DISCOVERY

When Ashley Hewitt found that he could receive signals with the antenna disconnected, he started experiments that brought results described below.

THE combination of ingenuity and a bit of luck sometimes leads to interesting results. Here is a letter from a fan who is not afraid to experiment:

Like most amateurs, I had been bothered a great deal by the larger wireless stations, particularly NAH and WNY, which broke in on the broadcasting and on the amateur work. I was unable to tune them out.

However, my problem is now solved, and, as is often the case with novices, I arrived at the solution entirely by accident. When I set up my two stage amplifying set, I used as a ground the discontinued city gas line which was left intact when electricity was put in the house. This seemed to work perfectly well, but I was still annoyed by NAH and others.

I was working with another amateur, trying to receive his signals, but was unable to get him; he suggested that I would get better results in any case if I grounded on the city water line. Accordingly I did this and found the strength of the signals vastly improved, as well as the clearness. Still I was bothered by the same trouble.

It was while listening to the 2XJ-KDOW tests that I made my "economical" mistake. I noticed that I could hear NAH with the antenna disconnected and the set tuned in.

This started me fooling with the antenna and ground connections. Trying everything that I could, just to see what would happen, I put the wire which I had attached to the gas-pipe on the antenna terminal while the ground terminal was connected to the city water line. NAH was going at the time as well as 2XJ, but as soon as I made this accidental connection they both disappeared. On tuning up a little higher I heard 2XJ clearly but not NAH. The signal was a little weaker but it was worth it to have all the interference out.

Attaching the gas-pipe to the antenna in this way seems to have the effect of putting a condenser of great capacity in the antenna circuit.

There are several other effects that should be spoken of in case anyone else wishes to try it. First, it reverses the tuning of the Vernier condenser—that is, instead of tuning around 0 to 20 degrees, I have to start from the other end at 100 and tune towards 80. It also shifts the point of tuning on the regenerative dial; this moves upwards about 20 degrees. The wavelength is also moved up higher about 3 degrees. Another advantage is that it increases the sharpness of tuning enormously; I find that in the amateur range I can practically cut all signals except those on identically the same wavelength. The adjustment is so fine that I will have to put micrometer adjusting screws on the dial to be able to get the signals I want.

I am using this hook-up entirely now.

ASHLEY HEWITT

Re-Making Lumber Jacks by Radio

THE old Bible adage "And the waste places shall be glad of their coming, and the wilderness shall blossom as the rose" has seldom been given more apt illustration than in the way that radio is bringing the advantages of civilization into the backwoods. For example:

> The lumberjack of the densely forested Pacific Northwest timber belt is now a radio fan. The click of poker chips is being supplanted by the voice of the radiophone. Evenings in the Northwest camps are now spent constructively, listening to news of the day, instructive talks and music.
>
> Giant tree-tops are used almost universally to anchor antennas. Many of the forest antennas are more than 300 feet high, swaying with the willowings of the trees. The Hammond camp, at Kerry, Ore., boasts a single wire aerial 1000 feet long. To fasten these antennas it is necessary for a "high climber" to scale the trees selected for masts, a feat calling for both nerve and skill. A lone coil of rope is thrown about the tree and by flipping the rope up the trunk a foot at a time, the climber pursues his way to the swaying top.
>
> Logging camp managers declare that since the incursion of radio into the lumber camps the spirit and tenor of the lumberjack has changed materially for the better. As a class, shrinking from the society of cities, the lumberjack nevertheless possesses that innate craving for music and the better things of life which embellish metropolitan culture. Radio gratifies that desire without the embarrassment of physical contact with the part of civilization which is strange to him. The radiophone is a permanent fixture in lumbercamps that are too small to support a motion-picture show and has become a potent factor in the Northwest timber belt. Recognizing the beneficial results of radio installations, several large camps are now constructing recreation halls capable of accommodating several hundred persons, in which daily programs will be given to audiences through power amplifiers. Dances will be held in the heart of the wooded wilderness to the tune of city jazz orchestras. Lumber operators freely admit that radio has raised the morale of the timber workers and that by its educational influences a changed order of woodsmen is being evolved.

MEL WHARTON

BETTER THAN BOX SEATS AT THE OPERA

The introduction of radio into the timber regions has given the backwoodsmen one inestimable boon—the privilege of listening to good entertainment without the necessity of putting on store clothes!

How to Find the Relation Between Frequency and Wavelength

SOONER or later the radio fan with an investigating turn of mind is puzzled by this question of relationship between frequency and wavelength. How the problem was worked out by one amateur and expressed in a simple formula is told as follows:

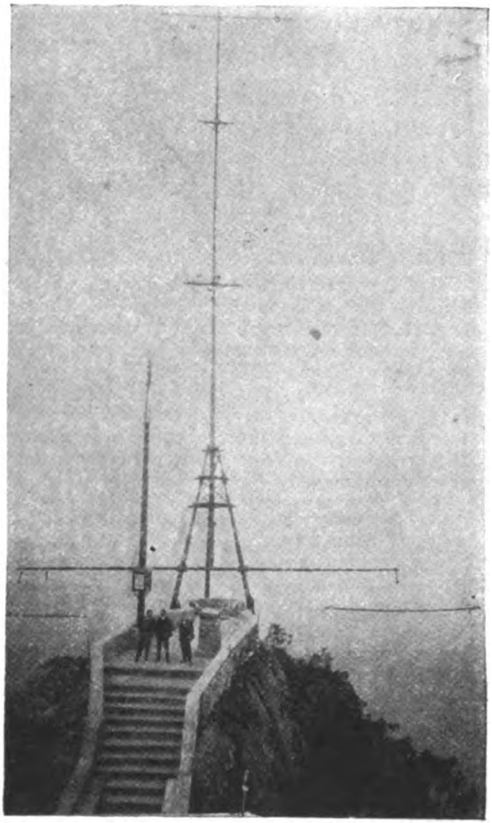
A real baseball fan is not content to know merely the score of a baseball game; he wants to know how every run was made, what players were responsible for winning or losing, indeed every move of the players throughout the game.

So it is with the radio fan. He is not satisfied with being able to hook-up the various units of his set and to tune the different stations in and out; he loves to speculate on the mystery of it all, to picture the waves coming in, producing currents in the aerial, to follow them as they surge through the apparatus, causing the little electrons to rush around through the coils and onto the plates of the condensers and back again several hundred thousand times every second. But in pondering over these mysteries there comes at some time to every amateur one puzzling question that will continue to trouble him until he finds a satisfactory explanation. It is the relationship between frequency and wavelength.

Nearly every amateur realizes that some relationship between these two exists. Some of us know that the lower the frequency the longer the wavelength, and the higher the frequency the shorter the wavelength. This relationship would be more easily understood if expressed by a formula similar to that of Ohm's Law. Frequency is defined as the number of cycles a second, a cycle being an electrical impulse in one direction followed by another impulse in the opposite direction. A complete cycle transmits one complete wavelength.

Now, it is an established fact that these magnetic impulses which carry the radio messages, travel at the rate of 186,330 miles per second. As wavelength is always given in meters we will express this distance in meters. If we multiply 186,330 by 5,280 (feet per mile) we have 983,822,400 feet per second; dividing by 3.28 (feet per meter) we have 299,945,853 meters per second. If we say 300,000,000 in round numbers it will simplify matters; it is accurate to within a small error of about thirty-four miles and will be near enough for practical purposes.

It is evident that if the message travels 300,000,000 meters per second and travels in waves and that if there are, say, 200,000 waves per second, we can find the wavelength by dividing 300,000,000 by 200,000. This gives us 1,500 meters. Any other wavelength may be found in the same manner by dividing 300,000,000 by the frequency (cycles per second). On the other hand, if we know the wavelength and desire to know the frequency we divide 300,000,000 by the wavelength in meters and we have the number of cycles a second of the current which is necessary to produce a wave of given dimensions.



Westinghouse

AN ANTENNA ON TOP OF THE WORLD

This new and unusual radio station, SPC, is perched on the summit of Mt. Corcovada in Brazil. It forges another link in the radio chain that encircles the earth.

The formula may be stated thus:

$$\text{Wavelength} = \frac{300{,}000{,}000}{\text{frequency}}$$

$$\text{or, frequency} = \frac{300{,}000{,}000}{\text{Wavelength}}$$

This is even simpler, in a way, than Ohm's Law, as in the latter we have three quantities, any one of which may be the unknown quantity. In the present problem we have only two, as the speed which is represented by the 300,000,000 meters is constant. A clear understanding of this phenomenon can be obtained from this simple formula; thus this puzzling question is answered and the mystery cleared away.

GUY PRENTICE BLESSING

Broadcasting a Voice from a Photograph

EVERY day opens up new and amazing possibilities for the use of radio; one of the latest applications forces one to speculate what kind of a world our grandchildren will live in. For instance:

> Holiday greetings to the people of the United States from Vice-President Calvin Coolidge, from Secretary of War Weeks, and from Secretary of Navy Denby, were broadcast from WGY, at Schenectady, N. Y. This was the first time that three leading executives of the country ever attempted to extend their greetings in a way that reached the four corners of the country simultaneously.

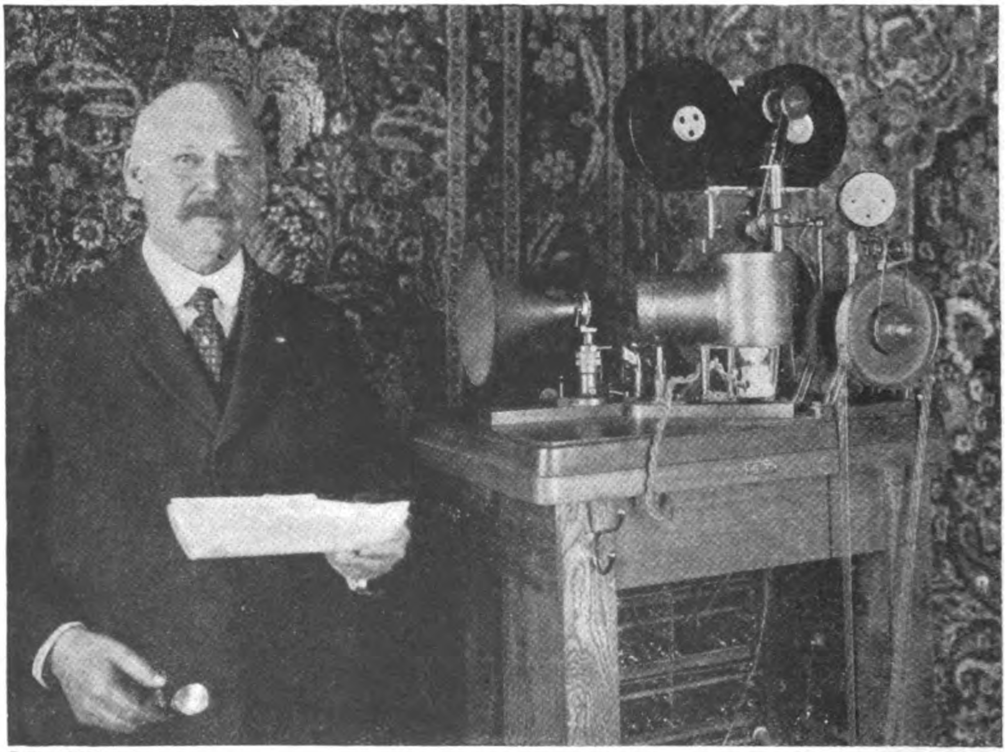
This feat was made possible by use of the "pallophotophone," the new General Electric device for photographing the voice and later reproducing it with perfect clearness. The machine was set up in a hotel in Washington ten days before. The Vice-President and the War and Navy Secretaries spoke into a small recording horn; as they did so their voices caused a small diaphragm to vibrate. To this diaphragm was attached a tiny mirror, scarcely smaller than the head of a pin. This oscillation or flickering of the mirror reflected a beam of light upon a moving photographic film, thus recording the human voice accurately with the overtones, the delicate shadings of speech and other characteristics which make one voice sound different from another.

The film thus made was taken to Schenectady and was broadcast twice on the same evening from the WGY studio.

In reproducing, the film is passed before a strong ray of light and the zigzag markings on it that the sound waves photographed create electric waves which pass through an arrangement of vacuum tubes and produce sound waves again which are sent directly into the radio broadcasting apparatus without the use of a microphone or any sort of a pick-up device ordinarily used.

This feat of recording the speech of a person in a distant city is believed to have introduced an entirely new element in radio broadcasting, the possibility of making a master record and broadcasting it days or weeks later from any radio station in the country.

B. S. Beach



General Electric

THE SECRETARY OF WAR HAS HIS VOICE PHOTOGRAPHED

By means of this "pallophotophone" a film record was made of the sound waves, which were re-converted at the broadcasting station into radio waves.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East 40th Street, New York City.*

A Seal on a Radio Cabin Saves Me from a Firing Squad

THE Destiny that looks after children and violators of the Volstead Act sometimes casts a friendly glance in the direction of radio men also. Certainly Destiny spread himself a bit in the following instance, which is cited by a ship's operator who served in the war zone during the U-boat days:

> During the early stages of the World War, before the United States was involved in it, we were sending ships laden with cotton to Bremen through the Allied lines. Ships that flew the American flag did not go through the British Channel; they went around the northern end of the British Isles and down the coast through the east side of the North Sea.
>
> Whenever a ship stopped for examination in an Allied port, the radio cabin was sealed up tight. The Germans even went the Allies one better; they removed the transformer and receiving apparatus before they sealed the radio room.
>
> On one occasion we had discharged our cotton, dodged the mines in the North Sea, been examined at Kirkwall and were wending our way back to New York when a storm came up. As the ship was light, the Captain thought it wise to put into a small port on the northwest end of Scotland. Immediately upon dropping anchor the usual crowd of officials swarmed aboard and commenced sealing everything up, in compliance with war-time regulations.
>
> Four or five of these officials stayed aboard until the storm had abated. Before leaving they gave us warning not to work the radio until outside the three-mile limit. I broke the seal on the door as soon as we were clear of the harbor and tried to get in communication with a sister ship about twelve hours behind us. As soon as I raised the other ship, I told her our experience and then went out on deck.
>
> But as soon as I put my head outside the door, I received a real shock. The storm had come up again with greater intensity than ever and we were headed back to the harbor, which lay to the east, not half a mile distant!
>
> I went in the ship's office to do some tall thinking—for I had seen three or four patrol boats with radio in the harbor and didn't know but what I might be apprehended for a German spy. Visions of a firing squad danced before me and the thought was not pleasant.
>
> As I sat there something on the Captain's desk caught my eye. Joy came over me; one of the inspection squad had left his seal, sealing wax and about ten yards of red tape on the desk.
>
> With it I quickly sealed up the radio room again; to make sure that I did a good job, I threw the seal and the rest of the works overboard. Then I assumed a detached air. When we dropped anchor this time about fifteen officials came aboard. The captain was asked by what right he used the radio within the three-mile limit. The officers wouldn't be convinced that we had not used it until they examined the seals. Finding them intact, they prepared to depart, with the usual super-Scotch blank looks on their faces.
>
> I had just begun to take full breaths again, and my blood pressure had about returned to normal, when one of the visitors turned back and asked if he had left his official seal behind.
>
> But somehow a thorough search failed to reveal it.

H. B. COWAN

What Awakened Me?

SOMETIMES Destiny appears to knock on our doors loud enough to awaken the sleepers. Certainly in this Adventure, which comes from an old-time ship operator, some power other than mere chance seems to have stepped in to help rescue lives at sea:

On the night of the 18th of January, 1913, while on the *SS Nigeria*, of the Elder Dempster Line, bound for the West Coast of Africa, I had copied the usual nightly bulletin from the high powered station at Poldhu, Cornwall, and afterward had a talk with operators whom I knew on the vessels in the vicinity. My bunk was alongside the operating table and along about 2:00 A. M., feeling sleepy, I turned in.

Exactly two and a half hours later I suddenly sat up in my bunk, wide awake and alert. I was certain that someone had called me. I got out of bed, went to the door and looked outside, but could see no one. I jumped into bed again but could not go off to sleep; I tossed about for ten minutes and then decided that I might as well listen in and see if there was anyone working.

I wound up the magnetic detector, put the telephones on and settled back on the pillows. I did not have them on my head more than three minutes when I heard "SOS, SOS," the call with which I was to become so familiar in later years.

Leaping out of bed and seizing paper and pencil I jotted this down:

SOS. SOS. Here SS "Veronese" on rocks off Leixoes.

We were then passing within 75 miles of Leixoes, Portugal.

I immediately started up the motor and answered "R," in acknowledgment of his call.

Without waiting to put on shoes or clothes I rushed along to the bridge and aroused the skipper, who changed our course at once and made for Leixoes.

Going back to the cabin I started up again and called the *Veronese*, but he did not answer. The steamer *Highland Laddie* then called me and said he was about thirty miles from the *Veronese* and was going at once to her assistance.

The *SS Vauban* then called both the *Highland Laddie* and myself and said he was in sight of the *Veronese* and would be able to take care of her. I so informed the commander, whereupon we changed our course again and proceeded on our voyage.

At Las Palmas we were informed that the passengers were taken off by breeches buoy erected between the ship and the shore. At an early hour of the rescue the wireless was put out of commission by a steel hawser that was thrown across the antenna.

The radio operator stayed on the bridge and kept communication with the shore by means of a Morse light. He and the captain were the last to leave the ship.

T. W. MURRAY

Old Pals Reunited by Radio

HOW radio reunited two long-lost friends is told in the following Adventure, which comes in the form of a story within a story. Incidentally, the newspaper account of the occurrence won a prize of a Ford car for the woman who wrote it up—who was the wife of one of the principals:

A remarkable incident was credited to radio when two old army pals were united and an old debt "paid in full." The true story of the exploit which won the automobile was reported as follows:

REUNITED BY RADIO

"When Professor Connor of Emerson College, Boston, gave his readings by radio from WGI broadcasting station near Boston last Wednesday evening, he was not aware that among his audience was a man whom he had been seeking for over three years, a pal of his army days. They had parted at the great army hospital on Staten Island and had gone their separate ways without having had an opportunity to shake hands in parting. Neither had heard of the other until Sergeant Kepple, listening in at Wilkensburgh, Pennsylvania, to the radio program heard the voice of his army chum with the result that the following night-letter was received by Mr. Connor the next morning:

> PROFESSOR JOSEPH E. CONNOR,
> Mansfield, Massachusetts.
> Been trying to locate you since discharged from army. Last night heard your radio readings. Am sending postal order amount one hundred dollars paying your kind loan at Army Hospital, Staten Island. Many thanks, old son-of-a-gun. Didn't know you were professor. Would have borrowed two hundred.
> Your erstwhile Sergeant,
> KEPPLE

"Mr. Connor says he is going to use the one hundred dollars for railroad fare to Wilkensburgh in a visit to Sergeant Kepple."

The author of this item is Mrs. Marguerite P. Connor, who feels well satisfied with the compensation which her husband secured as the result of his participation in a radio program, as he became richer by one hundred dollars, a touring car, a lost friend found and the gratification of the general public.

H. M. TAYLOR

The March issue of POPULAR RADIO is the All-Star Number

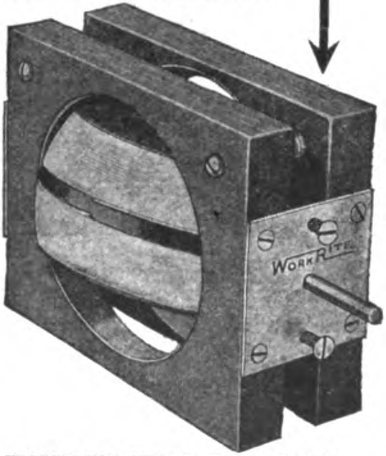
"WORKRITE" REDUCES PRICES

$3.50

WORKRITE 180° SUPER VARIOCOUPLER

RADIO FANS!

You have wanted to equip your set with WorkRite Quality Radio parts but have hesitated because of the cost. Now you can get WorkRite instruments at less than the prices asked for inferior unknown parts. Don't delay! Send in your order right away.

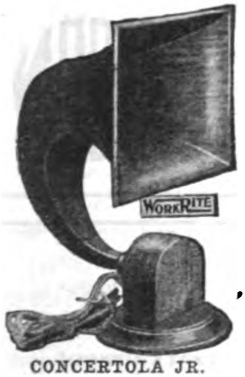


WORKRITE SUPER VARIOMETER

THIS IS A BIG CUT

The new WorkRite Super Variometer and WorkRite 180° Super Variocoupler with 12 taps and wound with green silk are now $3.50 each. Last spring they were $6.00. We have made this reduction because of our faith in you. We must sell 10 instruments where we previously sold one. Will you help us? We know you will. Remember the prices: WorkRite Super Variometer $3.50. WorkRite 180° Super Variocoupler $3.50.

WORKRITE CONCERTOLAS



CONCERTOLA JR.

These instruments are becoming very popular with radio fans. Thousands of them are in use all over the country. Read the following letter received from one of the "WorkRite" fans:

> "Regarding the WorkRite Concertola received some time ago I wish to advise that it is the best $12.00 worth I have ever bought. Stations in the following cities have all come in very QSA, even on warm nights, with the Concertola: St. Louis, Louisville, Pittsburgh, Detroit, Schenectady, Dallas, Tex., Fort Worth, Tex., Atlanta Ga., Havana, Cuba, Charlotte, N. C., Chicago, Cleveland and many others.
>
> These stations can be heard all over the room with ease on warm nights, and all over the house on colder nights. With ever a good word for the Concertola, I am,
>
> "EARL E. DAESCH, 1103 Columbia Terrace, Parkersburg, W. Va."

Three-Day Trial! If after you have tried the Concertola on your set you find that it does not work satisfactorily, return it and we will refund your money.

These instruments are intended for use with vacuum tube sets having two-stage amplification **WorkRite Concertola Jr., complete with cord and phone unit, $12.00. WorkRite Concertola Sr., complete with cord and phone unit, $24.00.**

LET US HELP YOU BUILD YOUR SET

THE WORKRITE MANUFACTURING CO.

5547 Euclid Ave. (Branch Offices, 2204 Michigan Ave., Chicago) Cleveland, Ohio

AT LAST!

A Receiving Set Without An Aerial

THE MOON RADIO CORPORATION

wishes to announce that they have secured the rights to manufacture the much talked of "Satterlee Antennaless Receiving Set."

Showing Model C 1 with Compartment for "B" Battery

Concerts have been received from Chicago, Detroit, Schenectady and many other distant stations on a loudspeaker without any aerial whatsoever. Stations as far west as California and as far south as Cuba have been heard from Long Island with an aerial.

This set will be known as Model C 1

Dealers and Jobbers: Some choice territory still open

Send two-cent stamp for literature

THE MOON RADIO CORPORATION

Manufacturers of Ultra-fine Receiving Sets

12 Diagonal Street **Long Island City, N.Y.**

MOON RECEIVING SETS
TRADE MARK

DELICATE SOLDERING

Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tip—Universal Current

One Half Actual Size

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York

Hearing is believing!

Bel-Canto

The Superlative Loud Speaker

Don't judge the Bel-Canto Loud Speaker by its beauty alone, or by the fact that it is the only loud speaker endorsed by the world-famous musician Paderewski. Don't judge it by its low price compared to other loud speakers.

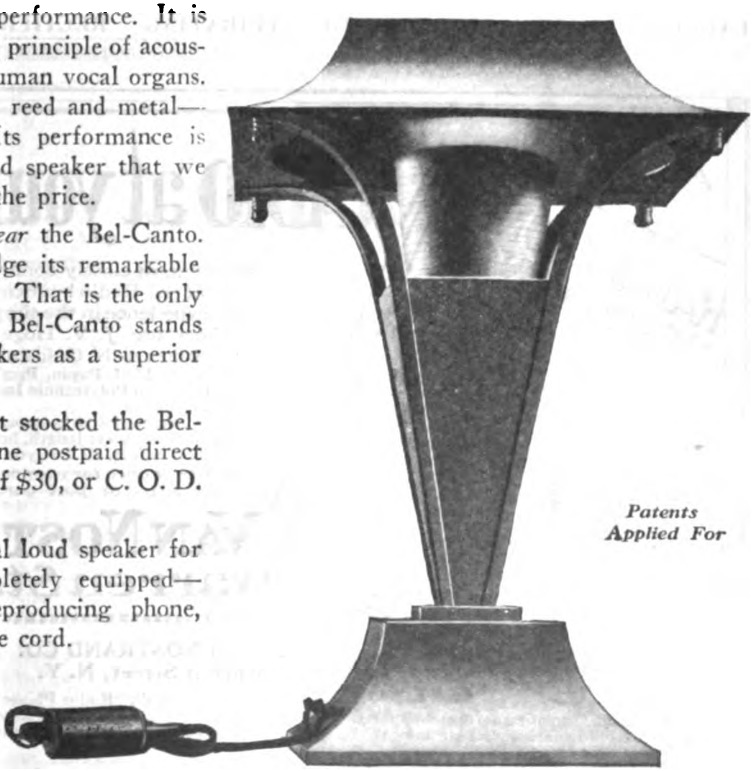
The way to judge the Bel-Canto, like any other fine musical instrument, is by *hearing* it—by hearing its warmth and mellowness of tone, its pure, distortionless reproduction of music.

Hear the Bel-Canto, then you will easily understand why we speak of the Bel-Canto as being in no sense of the word an ordinary loud speaker. The Bel-Canto is *different* in principle, construction and performance. It is designed on the most perfect principle of acoustics known to science, the human vocal organs. It is constructed entirely of reed and metal—absolutely distortionless. Its performance is unequaled by any other loud speaker that we know of—no matter what the price.

Go to your dealer and *hear* the Bel-Canto. That's the only way to judge its remarkable volume and clarity of tone. That is the only way to appreciate why the Bel-Canto stands apart from other loud speakers as a superior musical instrument.

If your dealer has not yet stocked the Bel-Canto, we will ship you one postpaid direct from the factory on receipt of $30, or C. O. D. if you prefer.

The Bel-Canto is the ideal loud speaker for the home. It comes completely equipped—including extra-sensitive reproducing phone, hard-rubber plug, and ample cord.

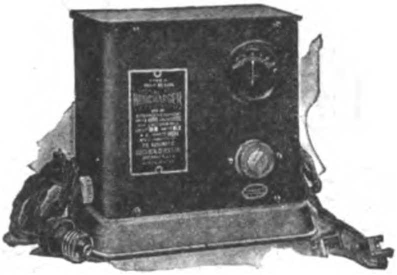


Patents Applied For

BEL-CANTO CORPORATION, 417 EAST 34th STREET, NEW YORK

Jobbers and dealers write for proposition

CHARGE YOUR RADIO BATTERY AT HOME FOR A NICKEL



THE
HOMCHARGER

is the original and most popular charger for this purpose. After an evening's entertainment connect to any convenient lamp socket, snap the clips on your battery and "turn in."

While you sleep the HOMCHARGER is silently charging your battery—the charging rate being governed automatically. In the morning it is fully charged—ready for another evening's work, and the cost has been less than a nickel for current consumed.

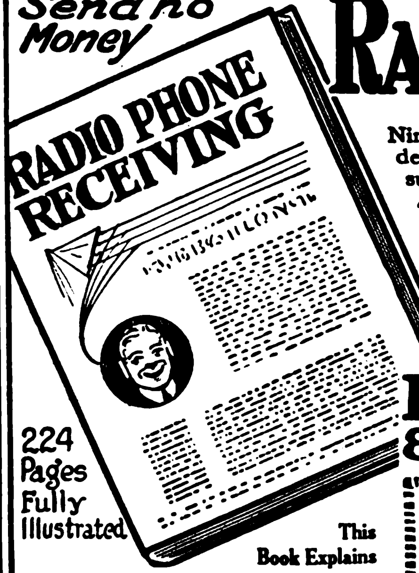
Beautifully finished in mahogany and gold—may be used anywhere in the home. No muss, trouble, dirt—no moving of battery or loss of time.

The simplest, most efficient and most reliable battery charger ever made. Only one wearing part—SELF-POLARIZING—FIVE TO EIGHT AMPERE CHARGING RATE—APPROVED BY UNDERWRITERS—UNQUALIFIEDLY GUARANTEED. Over 60,000 HOMCHARGERS now in use. Sold complete with ammeter, etc., by all good radio and electrical dealers for $18.50—no extras to buy. See the RADIO HOMCHARGER DE LUXE at your dealer's or write direct for our free circular, showing why the HOMCHARGER is the best rectifier built at any price.

MOTORISTS The HOMCHARGER will also charge your AUTO Battery.

THE AUTOMATIC ELECTRICAL DEVICES COMPANY
132 West Third Street :-: :-: :-: Cincinnati, Ohio
LARGEST MANUFACTURERS OF VIBRATING RECTIFIERS IN THE WORLD

Send no Money



224 Pages Fully Illustrated

RADIO at your Finger Tips

Nine of the men most closely connected with the tremendous development of the Radio have combined to give you the result of their experience in the simplest possible manner.

Among them are J. V. Hogan, Vice-President of the Radio Institute; A. N. Goldsmith, of the Radio Corporation of America, M. I. Pupin, Professor at Columbia; Dr. Hausmann, of Brooklyn Polytechnic Institute, and L. A. Hazeltine, of Stevens Institute.

In simple non-technical language they tell you how to receive messages of any wave length, how to select and operate your apparatus—in fact, all that you need to know.

Write at once for your copy, merely mail the coupon letter or post card. Postman will collect.

D. VAN NOSTRAND Co.
8 Warren St., New York.

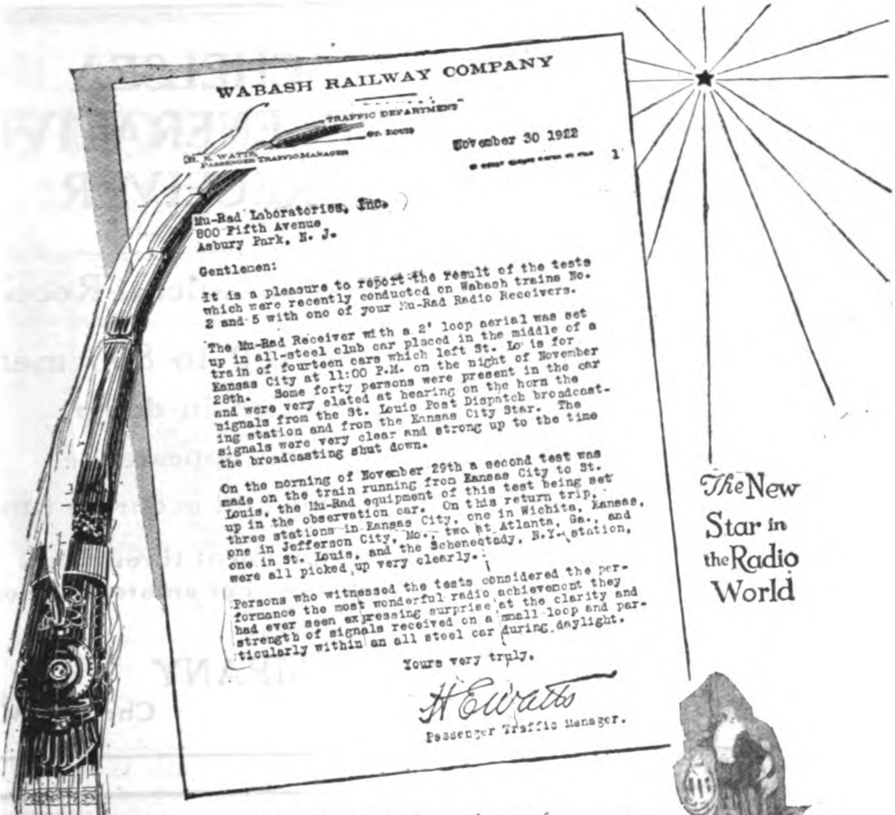
This Book Explains

How Electric Current carries Speech. Tuning. How to Accomplish Practical Methods. Why a detector is necessary to translate waves. The Vacuum Tube. Amplifying Music or Speech. Distortion. Regenerative and Heterodyne Reception. Noises. What Broadcasting is. Essentials. Apparatus, and hundreds of other facts.

D. VAN NOSTRAND CO. P. R.
8 Warren Street, N. Y.

Send me your book "Radio Phone Receiving." On delivery I will pay the postman $1.50. It is understood that I am to return the book if I am not satisfied and you will refund the money.—

Name..
Street..
City.............................. *State*..............................


The New Star in the Radio World

WABASH RAILWAY COMPANY

TRAFFIC DEPARTMENT
ST. LOUIS

H. E. WATTS
PASSENGER TRAFFIC MANAGER

November 30 1922

[illegible] 1

Mu-Rad Laboratories, Inc.
800 Fifth Avenue
Asbury Park, N. J.

Gentlemen:

It is a pleasure to report the result of the tests which were recently conducted on Wabash trains No. 2 and 5 with one of your Mu-Rad Radio Receivers.

The Mu-Rad Receiver with a 2' loop aerial was set up in all-steel club car placed in the middle of a train of fourteen cars which left St. Louis for Kansas City at 11:00 P.M. on the night of November 28th. Some forty persons were present in the car and were very elated at hearing on the horn the signals from the St. Louis Post Dispatch broadcasting station and from the Kansas City Star. The signals were very clear and strong up to the time the broadcasting shut down.

On the morning of November 29th a second test was made on the train running from Kansas City to St. Louis, the Mu-Rad equipment of this test being set up in the observation car. On this return trip, three stations in Kansas City, one in Wichita, Kansas, one in Jefferson City, Mo., two at Atlanta, Ga., and one in St. Louis, and the Schenectady, N.Y. station, were all picked up very clearly.

Persons who witnessed the tests considered the performance the most wonderful radio achievement they had ever seen expressing surprise at the clarity and strength of signals received on a small loop and particularly within an all steel car during daylight.

Yours very truly,

H E Watts

Passenger Traffic Manager.

What the Railroad said about the performance of the Mu-Rad Set on the Wabash Express

MU-RAD

Radio Frequency Amplification

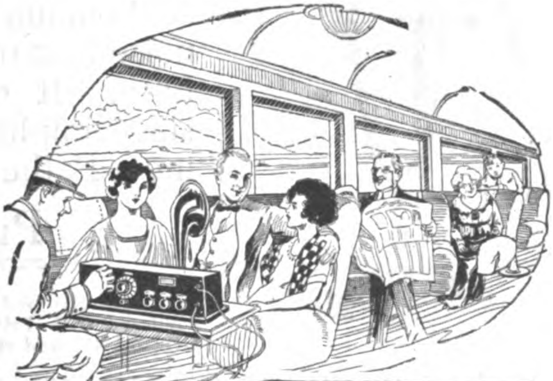
Triumphs in Test on Express Train

> *"They copied all they could copy,*
> *But they could not copy our mind;*
> *We left them tearing and swearing*
> *A thousand miles behind."*
> *—Kipling.*

THE entire radio world is agog at this latest supreme achievement—the reception of radio programs inside a steel car, with no outside aerial or ground, moving at express speed—the severest test ever given any receiving apparatus.

A striking demonstration of the great *sensitivity,* extremely *accurate selectivity* and absolute *simplicity of operation* of Mu-Rad Receivers.

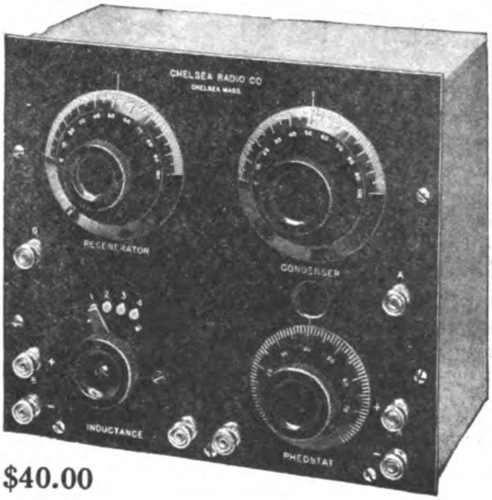
The difference between Mu-Rad and other apparatus is great enough to be worth your while insisting on Mu-Rad Receivers. Guaranteed reception of 1000 miles.



Type MA 12	***Type MA 13***
3 stages R.F. and detector, price, $128.	**3 stages R.F., and detector and 2 stages A.F., $160.**

DEALERS, write for interesting proposition!

Mu-Rad Laboratories, Inc.
809 Fifth Ave., Asbury Park, N. J.



$40.00

CHELSEA REGENERATIVE RECEIVER

A Real Broadcast Receiver

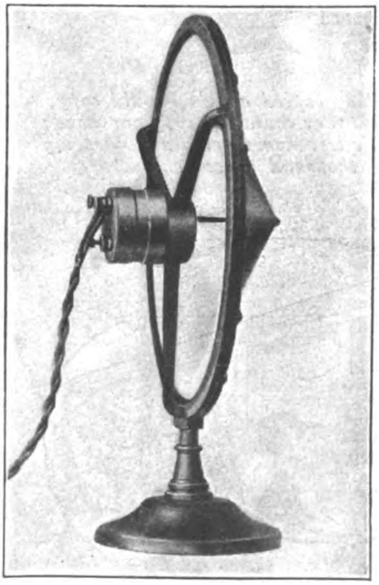
Range 150 to 800 meters

¶ Perfection in design
¶ Pleasing appearance
¶ Simple and accurate tuning

A Chelsea product, embodying Chelsea equipment throughout. Licensed under Armstrong U. S. Pat. No. 1113149. For amateur use only.

Write for our new No. 7 Catalogue

CHELSEA RADIO COMPANY
179 Spruce Street **Chelsea, Mass.**



THE PATHÉ LOUD SPEAKER

Has No Superior

It reproduces exactly the sound sent out and has none of the "tinny" noise that must come from a metal horn. It operates with any two stage amplifying set. Insist on hearing a Pathé operate before you buy.

Price, $24

THE SOUND WAVE CORPORATION has been consolidated with THE PATHÉ FRERES PHONOGRAPH COMPANY, and the new company is known as

THE PATHÉ PHONOGRAPH AND RADIO CORPORATION
30 Grand Avenue, Brooklyn, New York
Makers of Quality Dials, Variometers, Variocouplers, and Loud Speakers

NO MORE
STORAGE BATTERIES

The new WD-11 vacuum tubes requiring but a single dry cell to heat the filament have opened up a whole new field in radio. Sets are now brought within the reach of vast numbers who could not even consider them before. These new tubes differ in construction from the older types of tubes and require different associated instruments. For this service we announce the following:

TYPE 300-A AMPLIFIER UNIT

A compact unit consisting of our Type 231-A Amplifying Transformer, Type 225, Filament Rheostat and Type 282 WD-11 Tube Socket mounted on a nickel finished brass mounting. These parts are all wired ready for the external connections. The mounting is so designed that the unit may be used on a table or mounted behind a panel with only the rheostat knob projecting.

Price $7.50

TYPE 282 WD-11 TUBE SOCKET

A socket of molded bakelite arranged with positive contact springs to take the WD-11 tubes. This is a socket in itself, not an adapter.

Price . . . . 80 Cents

TYPE 255 RHEOSTAT

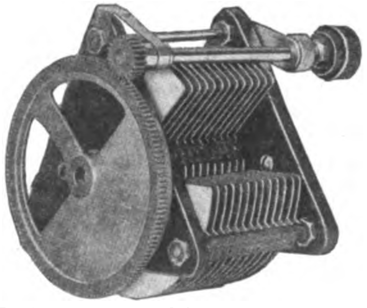
A rheostat of molded bakelite, not a substitute, for panel or table mounting, smooth in operation and attractive in appearance. Resistance 6 ohms, with current carrying capacity of 1.25 amperes.

Price $1.00

TYPE 247 CONDENSERS

These already popular condensers may now be equipped with gear and pinion providing a vernier adjustment with but a single setting. A low loss condenser with a micrometer adjustment at a fair price. Used in large quantities by such representative organizations as the Western Electric Company. Made in eight types.

Prices . . . $3.25 to $7.75



TYPE 231-A AMPLIFYING TRANSFORMER

Remember that this transformer is particularly suited to the WD-11 tubes.

Price $5.00

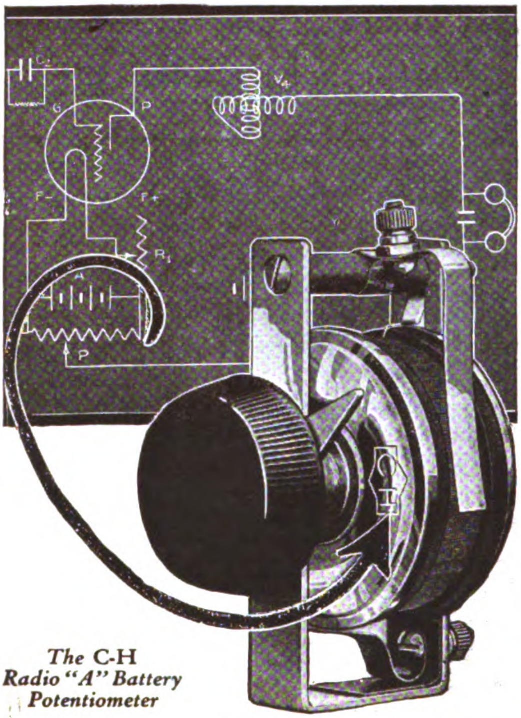
Send for NEW FREE RADIO BULLETIN 913-U and learn about these instruments

GENERAL RADIO COMPANY

MASSACHUSETTS AVENUE AND WINDSOR STREET
CAMBRIDGE 39 MASSACHUSETTS

Do not confuse the products of the GENERAL RADIO CO. with those of other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific, instruments for many years. It has no affiliation with any other company.

Standardize on General Radio Equipment Throughout



The C-H Radio "A" Battery Potentiometer

Another Opportunity to Demand C-H Protection

The C-H trade mark has made its place in the history of radio. More than a quarter million rheostats engraved with this mark of the master builder of rheostatic control apparatus are today giving satisfaction to an army of enthusiasts.

The new "A" Battery Potentiometer gives the same assurance of satisfaction in any equally vital part of your receiving circuit—the same assurance that has for more than thirty years made engineers the world over demand the C-H trade mark for protection.

This new potentiometer matches exactly the C-H Radio Rheostats in both appearance and performance. It is of the revolving drum type with a total resistance of 300 ohms. It is designed for panel mounting and finished in satin nickel and ebony black. A comfortable knob of genuine Thermoplax and a highly nickeled pointer provide easy and positive control.

To be certain of results demand the C-H trade mark—it is your guarantee of satisfaction.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE • WISCONSIN

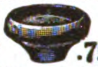
Over a Quarter Million C-H Radio Rheostats Now in Use

C-H RADIO "A" BATTERY POTENTIOMETER

Loud Speaker $1 Adapter

$1

Hear all broad-casting through phonograph. Make your own horn. Attach B-R Phonadapter to YOUR phonograph. All can hear. Entire family, neighbors, guests can hear operas, lectures, latest news, with this adapter. Stretches over receiver of Baldwin or Brandes type head-set and attaches to tone-arm of ANY phonograph. Made of soft, pure gum rubber. Quickly attached and removed. Thousands in use. Absolutely no voice distortion. For single receiver.................................... .75



For pair of receivers (more than twice the volume) $1

Amplitone Loud Speaker

An inexpensive, loud speaking horn especially adapted for home use. Ample volume. Quality tones. Throat of horn consists of successive sound expansion chambers. Each chamber amplifies previous one. Furnished either with single or double B-R Phonadapter. Price only.. $8

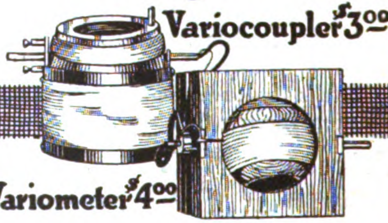
Bell Horn

A Bell Horn with ball swivel. Turns up, down, to side—any angle desired. Automatic adjustment. Very simple. No screws, thumb nuts, etc. Black finish. Complete, with phone, ready to attach to two stage amplifier........... $15

The Beckley-Ralston Co.
1825 So. Michigan Ave.
Chicago, Ill.

Go to your dealer. If he cannot supply you send money order, check or currency at our risk. Prompt delivery — postpaid. Also send us name of favorite dealer.

Both Selling Fast Because the Price is Right!



Variocoupler $3.00

Variometer $4.00

Set of Three

2 Variometers $8.00
1 Variocoupler $3.00
~~$11.00~~

a "Chi-Rad" *Special* $10.00

Send Your Order in To-day

OUR NAME PROTECTS YOU

CHICAGO RADIO APPARATUS CO.
415 So. Dearborn Chicago.

If you had a dozen ears

You would need them all to hear what you get nowadays with a single circuit receiver.

With several hundred powerful broadcasting stations, all operating on one narrow wave band, it takes real selectivity and sensitivity to get a satisfactory radio programme.

The Paragon three-circuit receiver gives you any station you want when you want it — and no other. Clear, complete programmes without interruption or disturbance. A modern, high-grade, scientific instrument built right to give results.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its greatly superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

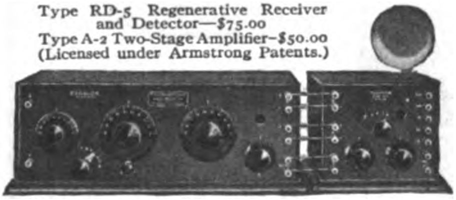
An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Also Manufacturers of PARAGON

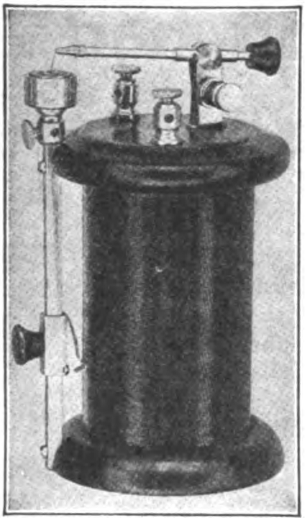
Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers



Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)

Crystal Receiving Set

$2.50



The Ritter Grand Crystal Set is everything that the beginner could wish for. This set will tune up to 600 meters and will receive broadcasting stations from 25 to 50 miles. It is made of all wood body with mahogany finish, stands six inches high and has the guarantee of high-class receiving qualities with a 100% rating by the Technical Department of POPULAR RADIO.

Free circular of set with instructions on how to direct your aerial sent upon request.

To dealers: This is the latest crystal set placed before the public and all sample orders from dealers have been followed by quantity orders.

Write for our interesting proposition.

RITTER RADIO CORPORATION

232 Canal Street New York City

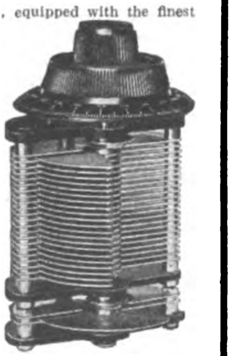
DEPENDABLE

And so recognized by the leaders in the Radio World

"UNITED" CONDENSERS *and* TRANSFORMERS

Have won the universal good-will of the men most worthwhile in Radio engineering.

Product of an $800,000 factory, equipped with the finest precision tools and backed by a high-priced staff of seasoned engineers, these instruments represent the highest achievements in the young giant industry.



"UNITED" Variable Condensers

VERNIER TYPE (*Like cut*)

Only Vernier with Stop. Complete with knob and dial postpaid

46 Plate $6.50 26 Plate $5.50

PLAIN TYPE

(without Vernier, dial or knob)

43 Plate	**$4.50**	**5 Plate**	**$2.75**
33 Plate	**4.00**	**3 Plate**	**2.25**
11 Plate	**3.50**	**postpaid**	

"UNITED" AUDIO FREQUENCY TRANSFORMER

The direct route to loud, clear signals. A standing challenge to all other makers. Ratio 5 to 1. Magnetically shielded. A beautiful job of workmanship.

List price..........$4.50

UNITED MFG. & DISTRIBUTING CO.

536 LAKE SHORE DRIVE, CHICAGO

Compare These Prices

WHY PAY MORE WHEN YOU CAN GET ROCK BOTTOM PRICES FROM US

Just glance over our list and send us your Money Order. Twenty-four hours after receiving your order it is on its way to you.

LIST PRICE		OUR PRICE
$ 5.00	Radiotrons UV-200	$ 4.25
6.50	" UV-201	5.75
16.00	Baldwin Phones, type C	12.00
7.75	" Units Loud Speakers	6.00
8.00	Federal 2200 Ohm Phones	6.00
8.00	Brandes Superior "	7.00
5.00	Acme Transformers	4.25
1.00	Double Jacks	.60
.70	Single "	.50
2.50	Bull-Dog Plugs	1.25
	Contact Points, per doz	.15
	Switch Levers, 1½" radius	.25
45.00	Magnavox	38.00
1.50	100 ft. Stranded Aerial Wire	.50
.50	Aerial Insulators	.20
1.00	100 ft. Stranded Aerial Wire	.40
75.00	Paragon RA-10 Set	68.00
25.00	90 ampere guaranteed Storage Battery	18.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.75
1.00	Vacuum Tube Sockets	.65
18.50	Homchargers	15.50
3.50	B. Batteries volt meters 0-50 V	2.75
55.00	Western Electric New Style Loud Speakers	42.75
.75	Rheostats	.60
3.00	B. Batteries	2.25
2.50	" "	2.00
1.75	" "	1.10
1.50	Dials	.75
1.00	"	.40
2.75	De Forest Detectors	1.95
.75	Sockets	.60
6.50	Westinghouse WD-11 Tubes, operated on 1 Dry Cell	5.98
1.00	Westinghouse WD-11 Sockets	.65
4.50	Thordarson Transformers	3.75
2.00	Potentiometers	1.25
	½ Megohm Grid Leaks	.60
	1½ " " "	.65
1.00	Grid Leak Holders	.65
1.00	Double Phone Cords	.60
.50	Single " "	.35
	Duplex Phone Adapters, fits Edison, Victor or Columbia	1.75
	Genuine Bakelite Panels, per sq. in.	.02
	Spaghetti, per ft.	.09
12.00	Genuine Western Electric Signal Corps V.T.-2-Tubes	9.00
112.00	De Forest type Honeycomb Set, special Mahogany Cabinet	65.00
3.00	Racony Electric Light Aerial	2.00
35.00	Audmiax Loud Speakers	18.50
6.50	Turney 3,000 Ohm Phones	4.25
4.50	Diamond 2,000 Ohm Phones	3.75
5.00	Fischer Variometers	3.75
6.00	" "	4.75
5.00	" VarioCouplers	3.75
6.00	" "	4.75
8.00	Atwater-Kent Variometers	7.00
8.00	" " VarioCouplers	7.00
5.00	Pathe Variometers	3.75
14.00	Atwater-Kent Mounted Vario-Couplers	11.75
16.00	Atwater-Kent 2-step amplifier	13.75
8.50	Everet Head Phones, 3,000 Ohms	4.95
1.50	Thordarson Rheostats	1.15
	Bus Wire for wiring sets, per ft.	.02

Honeycomb coils, all sizes, 20% discount. Space being limited, we are obliged to omit many items.

Write for our Quotations

Cut Rate Radio Co.

Dept. A P. O. Box 472 Newark, N. J.

Radio
WIRELESS TELEPHONE
WIRELESS TELEGRAPH
EQUIPMENT
Montgomery Ward & Co.
Satisfaction Guaranteed or Your Money Back
Chicago Fort Worth Kansas City Portland, Ore. Saint Paul
Map of Broadcasting Stations
Complete Selection of Parts
Dictionary of Radio Terms
Large Selection of Outfits
Study These Diagrams and Definitions
Antennae Aerial

Radio

Catalogue FREE

One copy of this complete Catalogue of Radio Outfits, parts, Dictionary of Radio Terms, Instruction Book, and Guide to Successful Radio Work—one copy is yours Free.

Simply write us a post card and we will mail the complete book to you Free, by return mail.

It quotes the lowest prices, amazingly low prices on everything for the expert and the amateur. Every improved part, the most up-to-date outfits, everything that is needed of the most modern type—at the lowest possible prices.

It gives a list of broadcasting stations, and gives much information about radio construction and operation. Every one interested in Radio needs this complete catalogue and book of instruction.

Why Pay Higher Prices?

Montgomery Ward & Co. has for fifty years dealt on a Money-Back basis, absolutely guaranteeing everything they sell. With quality absolutely assured, why pay higher prices elsewhere? Write today for this Free Radio Book and see for yourself the Saving it will bring you.

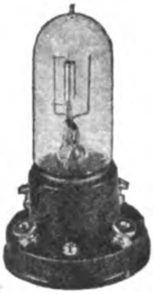
One copy is yours Free. You need only write us a post card.

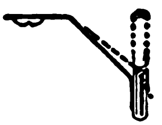
Write to the house nearest you.
ADDRESS DEPARTMENT 38-R

Chicago Kansas City St. Paul
Fort Worth Portland, Ore.

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive





It's the contact that counts

The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

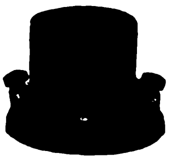
Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.

The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each

ALDEN - NAPIER CO.
Dept. C **52 Willow Street**
Springfield, Mass.

NA-ALD



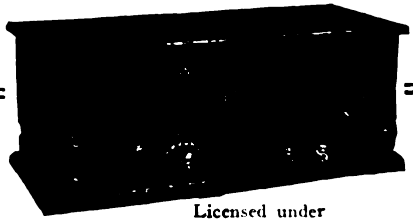
Have we received your order for the 1923 Ace Radio Broadcast Receiver?

If not, you still have an opportunity to get immediate delivery if you place your order NOW!

Let us send you our booklet, "Radio in your home."

Address Dept. XM

THE PRECISION EQUIPMENT CO.
2437 Gilbert Avenue Cincinnati, Ohio



Licensed under
Armstrong U. S. Patent
No. 1,113,149

BRILLIANTONE RADIO PRODUCTS

Dept. C—874 Columbus Ave., New York

$1.00 Brings any one of these Combinations quickly to you

No. 1

100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lighting switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

No. 2

1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detecter stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.

No. 4

1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.
1 Spool No. 24 cotton covered wire, 375 feet.
1 Hardwood Rotor.
All the above merchandise guaranteed or money refunded.

— — — — — — — —CUT HERE— — — — — — — —

Please Check Before Items Desired—Fillin Coupon and Mail

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐	B.R.P. Rheostats, fibre base (Tapered Type)...	$ .50
☐	B.R.P. Rheostats, porcelain base..............	.75
☐	B.R.P. Potentiometer (200 ohms)...............	1.00
☐	B.R.P. Moulded Sockets (unbreakable)..........	1.00
☐	B.R.P. Audio Frequency Transformers (11 to 1)	4.00
☐	B.R.P. Radio Frequency Transformers (150 to 500 M.)........................	3.00
☐	B.R.P. Variometer (to 800 meters).............	3.00
☐	B.R.P. Variocouplers (Panel and Laboratory Type in one)............................	3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐	3 Plate, capacity .00005.....................	$1.50
☐	7 Plate, capacity .0001......................	2.00
☐	11 Plate, capacity .0003.....................	2.50
☐	23 Plate, capacity .0005.....................	3.00
☐	43 Plate, capacity .001......................	8.50

TYPE "B"—ALUMINUM ENDS

☐	3 Plate, capacity .00005.....................	$1.00
☐	7 Plate, capacity .0001......................	1.25
☐	11 Plate, capacity .0003.....................	1.50
☐	23 Plate, capacity .0005.....................	1.75
☐	43 Plate, capacity .001......................	2.25

STANDARD MERCHANDISE AT REDUCED PRICES

☐	$4.50 Thordarson Amp. Transformers (Audio)	$3.00
☐	$7.00 UV712 Audio Frequency Transformers (Radio Corp.)...........................	6.00
☐	$6.50 UV1714 Radio Frequency Transformers (Radio Corp.)...........................	5.50
☐	ZETA Radio Frequency Transformer..........	3.50
☐	Brandes "Superior" (2200 ohms)............	6.75
☐	Murdock (3000 ohms).......................	5.00
☐	Federal (2200 ohms).......................	6.50
☐	Klosner Vernier Rheostat..................	1.00
☐	Bradleystat (Best Vernier)................	1.65
☐	Jacks, single, open or closed (Firth).....	.35
☐	Jacks, double, closed (Firth).............	.50
☐	Plugs, bulldog grip (Firth)...............	1.00
☐	.002 and .005 Mica-Bakelite Condensers....	.25
☐	.0005 and .00025 Condensers with Var. Leak....	.25
☐	.0005 and .001 Fixed Mica-Bakelite Condensers	.20
☐	Flewelling super-regenerative diagram.........	free

BRILLIANTONE RADIO PRODUCTS
Dept. C, 874 Columbus Avenue, New York

Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

Name ....

Address ....

City ....

BEST

A word I hate to use

ALL of you know what it means. No explanation is necessary and it conveys the idea quickly. Yet, "best" is a word that most ad writers hesitate to use because it has been so often used that it is discounted by readers. Personally, I detest it; yet when I was gathering the data for this advertisement, talking to the men who visioned, planned and are building Kennedy radio equipment, their enthusiasm and sincerity was so catching that they convinced me that Kennedy radio is the best. After investigating their claims as to the best design, the best material, the best workmanship, by talking with radio people outside of the Kennedy Company, I am still convinced that it is the best. Yet, I cannot conscientiously pass my opinion on to you who read this advertisement.

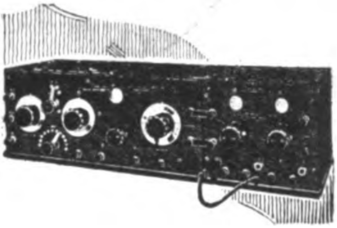
I spent a week at the Chicago Radio Show and was truly surprised at the number of people that came into the Kennedy booth and voluntarily lauded Kennedy radio equipment in terms that I should certainly hesitate to use in talking to you. For instance, one day I came upon a "ham" operator standing in front of a Kennedy 110 Universal Receiver, praising it to himself and fondling it as if it were a jewel. Upon asking him what he thought of it he answered: "This makes my set look sick. I have been in the radio game nine years. Four years ago I was an operator on a Lake steamer. I have built a set of my own and I considered it a wonder. It cost me over $600, much more than a Kennedy outfit, and it's nowheres near so good in either performance or appearance. Kennedy is the best I have ever seen and I have seen a lot of them."

One afternoon a telegrapher, or "brass pounder," as he called himself, came in and after looking over various equipment said: "I have been through every booth at the Show, and have not seen anything to compare with the Kennedy sets. They certainly are the best at the Show."

On that same afternoon a man volunteered the information that while he knew very little about radio, as a shop foreman in the employ of a large electrical manufacturer he was a competent judge of good workmanship. He said: "You people certainly must employ considerable care in your shop methods. This wiring is as good as any I have ever seen anywhere; a whole lot better than that employed by most radio manufacturers. The coils are beauties and I don't think the cabinet work could be improved on. It's the best radio equipment that I ever ran across."

So, while I personally detest the use of the word, I am heading this advertisement "Best," because it is not my opinion I am expressing, and apparently the people whose comments I have quoted have no aversion to the word "best"—at least not when they refer to Kennedy radio equipment.

The Ad Writer



For broadcasting service

Kennedy Type 281 Short-wave Receiving Set. Tuning range, 175 to 620 meters. Highly efficient for receiving from broadcasting and amateur stations. Designed throughout in accordance with the most advanced radio engineering practice. Inductively coupled circuits permit elimination of interference. Solid mahogany cabinet, hand-rubbed finish. An ideal set for home entertainment. Price, including amplifier, $145.

* * *

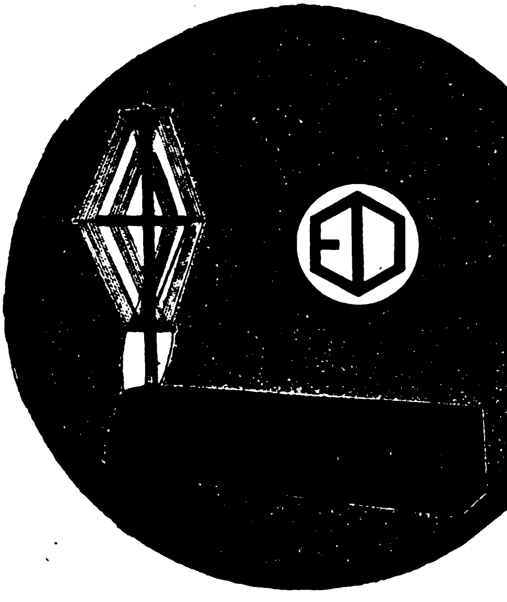
All Kennedy Regenerative
Receivers are licensed under
Armstrong United States
Patent No. 1,113,149.

THE COLIN B. KENNEDY CO.
SAINT LOUIS SAN FRANCISCO

KENNEDY

0120-6

Have You Heard About *"The Set That Grows"?*



It's just the set you've been looking for, sturdy, simple and practical, made in high-grade units or panels that can always be added to.

You can start your set with only two of these efficient panels and have a high-grade station from the beginning while you are assured of the same uniform appearance and results as the set grows.

Each unit is individually shielded and constructed; each matches the other and all combinations work just as good as they look.

Write to us for all the interesting information about this set. Be sure you mention your dealer's name and address.

THE E-D MANUFACTURING COMPANY
3301 Arch Street
Philadelphia Penn.

LOUD SPEAKER FOR ANY CRYSTAL SET

The STEINMETZ Amplifying unit now selling for $8.50 will enable you to hear your crystal set all over the room. No storage battery required. ALL STEINMETZ equipment is thoroughly guaranteed.

Steinmetz 3000 Ohm Phones, $6.50
Steinmetz 2000 Ohm Phones, $5.00
Steinmetz 1000 Ohm Phones, $1.75

Equal to any $10.00 or $12.00 phones made. Complete catalogue Five (5) cents at your dealer or

STEINMETZ WIRELESS MFG. CO.
5706 Penn Ave., Pittsburgh, Pa.

DELAWARE CORPORATIONS

ORGANIZED and REPRESENTED

$ 100,000 corporation complete $ 73.00
$ 500,000 corporation complete $113.00
$1,000,000 corporation complete $163.00

24 Hour Service

OUR PRICES AND SERVICE WILL PLEASE YOU.

Correspondence Invited.

Lawyers Corporation Company
"owned and operated by attorneys"
Equitable Bldg., Wilmington, Del.

DUCK Radio Pioneer Announces Startling Reductions

Leading Line Since 1909 At Prices to You Less Than Dealers' Cost

FREE Illustrated pamphlet comprising sixty-two Duck radio instruments and sets with reductions averaging 30% mailed on request. Send postal today. Any old-time radio amateur will tell you who we are and our reputation. Only a few years ago almost one-third of the radio instruments sold at retail, exclusive of sales in only a half dozen large cities, were sold by Duck.

A Few of the Many Duck Products at Sensational Prices:

Rheostat, 70c; Bakelite moulded positive contact, 70c; Bakelite Moulded Dial, 55c; superselective moulded variometer, $4.65, worth $8.00; radio frequency potentiometer, $1.15; solid mahogany form variometer, $3.60; 43-plate panel-type variable condenser, pigtail connection, $3.15; detector panel, $5.25; receiving set, mahogany cabinet, detector and two stages of audio frequency, $59.50; radio frequency receiving set with one-step radio and detector, $29.75.

SEND 25c in coin or money order for our big 256-page combined radio catalog and text book. For radio information and hook-ups it is worth many times the retainer asked.

THE WILLIAM B. DUCK COMPANY, 227-229 Superior St., Toledo, Ohio

From BARCELONA to TOKIO The MUSIC MASTER Wins Approval
BARCELONA
MUSIC MASTER Radio AMPLIFIER

Two-thirds the way around the world radio enthusiasts are learning to appreciate the superiority of the Music Master Radio Amplifier. You ought to see it . . . . Our plan makes both seeing and hearing easy. Any reputable dealer will demonstrate the Music Master in your home.

Send us his name and we will make sure that he has one on hand to show you.

Fourteen-inch aperture (Home Model)	**$30**
Twenty-one-inch (Concert, Dancing, etc.)	**$35**

Complete ready to attach in place of headphones. No tubes or batteries required.

True tone at last: Music Master Horn Conquers Screech, Snarl and Howl and makes listening a joy.

Jobbers and Dealers

Sample Horn shipped to responsible members of the Radio or Phonograph trade with *full privilege of return.* List-prices and full details on request.

"Geraco" is the brand name

which absolutely guarantees the merit of every Radio product upon which it is placed. Complete data, including prices and literature, on request.

The Geraco Phonograph Attachment makes your Victor or Columbia into an excellent Radio Speaker. No head-sets needed — interchangeable with sound-box $10

GENERAL RADIO CORPORATION
Makers and Distributors of High Grade Radio Apparatus
624-628 Market Street, Philadelphia
Chicago Pittsburgh

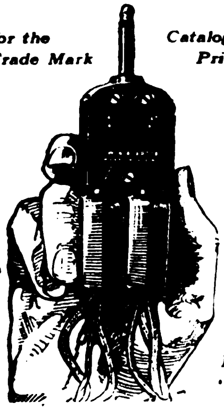
GERACO
PROVEN RADIO PRODUCTS

Double Your Radio Fun

The PACENT TWINADAPTER allows a single jack to accommodate TWO plugs. TWO pairs of phones can be used, or one pair of phones and a loud speaker. One of the many useful Pacent Radio Essentials. Send for booklet P2.

Look for the PACENT Trade Mark

Catalogue No. 51
Price $1.50



Don't Improvise
"PACENTIZE"

PACENT ELECTRIC COMPANY

INCORPORATED

Executive Offices: 22 Park Place, New York, N. Y.
Chicago Philadelphia Washington, D.C. San Francisco
Canadian & British Licensees, Colonial Radio, Ltd., Hamilton, Can.

A good article is always imitated!

Be sure you receive the

FRESHMAN Variable Grid Leak and Micon Condenser Combined

Price only $1.00

3 Points to Remember

1. It is hermetically sealed in a mould to prevent moisture from affecting the grid resistance.
2. It has an unbroken range from zero to 5 megohms, allowing proper adjustment for maximum efficiency of detector.
3. It contains a tested Micon Condenser of .00025 M. F.

At your dealer's—otherwise send purchase price and you will be supplied without further charge.

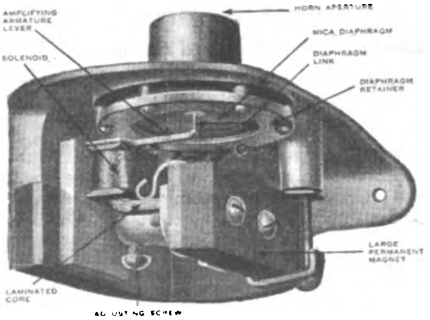
Manufactured by

CHAS. FRESHMAN CO., Inc.
97 Beekman Street NEW YORK CITY

The Trinity Loud Speaker

Type "B" $12.50

The Only Device of Its Kind in the Radio Field



Study the illustration carefully and you will understand why it produces full, clear natural tones with perfect reproduction of all vocal and instrumental music. May be used with phonograph. No storage battery required. If your dealer hasn't it, we have.

Trinity Radio Company

Trinity Bldg., Dartmouth St., Boston, Mass.

The first man to listen over a telephone

didn't hear very much. Today he listens with comfort and complete understanding. The difference is due to better apparatus.

The AmerTran

super audio frequency amplifying transformer gives 38.6 times audibility in your receiving, without distortion. Two stages (2 AmerTrans) give 1490 times audibility. It is doubtful if the substitution of any one thing in a radio set could make such a notable improvement as the installation of AmerTrans.

Price $7.

Ask your Electrical Dealer or sent carriage charges collect (Wt. 1 lb.)

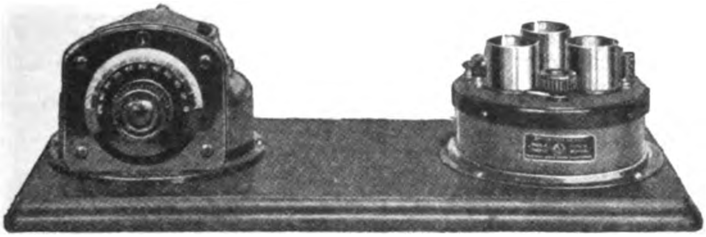
American Transformer Company

Designers and builders of radio transformers for over 20 years

175 Emmet St., Newark, N. J.

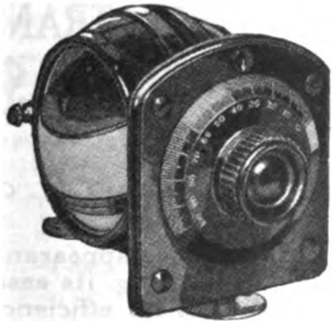
ATWATER KENT

RADIO RECEIVING SET



THE above set, consisting of Coupled Circuit Tuner and Detector 2-Stage Amplifier, is an ideal set for either phone or loud speaker use. Note that this set includes two stages of audio frequency amplification.

Complete Outfit, as above, wired, $35.50



The Mounted Variometer carries through the standard quality of ATWATER KENT products. For an open set it supplies a finished instrument unsurpassed in appearance and performance.

Mounted Variometer, $10.00

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

MICON TESTED MICA CONDENSERS

Assure—

Absolute noiselessness
Clarity of tone
Accuracy
Constant fixed capacity

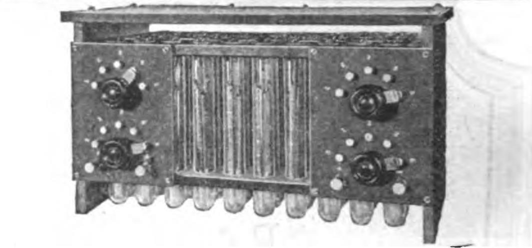
Size	Price
.00025	$0.35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.01	1.50

Micon Condensers are especially adapted for use with Radio-Frequency, Super-Regenerative and other circuits, where an accurate fixed condenser is required.

For protection against damage to the filament and the consequential short life of filaments, Micon Condensers are invaluable.

At your dealers—otherwise send purchase price and the desired Micons will be sent without further charge.

Chas. Freshman Company, Inc.
97 Beekman Street New York City



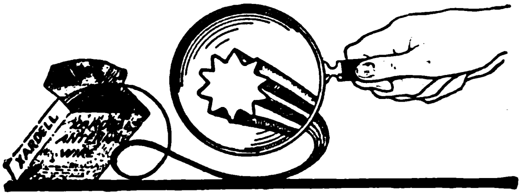
KICO Radio Storage "B" Batteries for EFFICIENT Receiving

1. KICO "B" batteries allow single cell variations by means of switches mounted on panels. (The first in the market with this feature.)
2. Alkaline type.
3. Rechargeable from your 110-volt A. C. line in connection with the rectifier supplied.
4. One charge lasts from three to six months in the detector plate circuit.
5. Neat, efficient and compact.
6. Unlimited life.
7. Your money back if unsatisfied within a 90-day trial.

	(Plain)	(With Panels)
16 cell 22 volt	$6.50	......
24 cell 32 volt	8.00	$12.00
36 cell 48 volt	10.00	14.00
50 cell 68 volt	12.00	17.00
78 cell 100 volt	16.00	21.00
108 cell 145 volt	21.00	26.00

"A" and "B" Battery Literature gladly furnished

KIMLEY ELECTRIC COMPANY
1357 FILLMORE AVENUE BUFFALO, N. Y.



Something Brand New in Antenna Wire

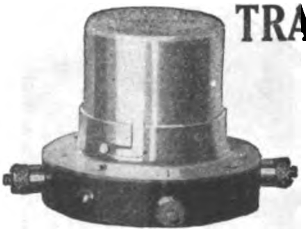
$1.50 PER HUNDRED FEET

That will at once appeal to you. It is different and better than any makeshifts to date, being hard drawn from the finest copper having a corrugated surface with 10 collecting points on its circumference. This gives a greater collective and gathering surface. The result is extreme sensitiveness, and an increase in the range and clearness of any set from the simplest crystal type to the finest V. T. Receiver.

Packed in neat cartons of 100 feet 200 feet and 500 feet.

Dept. R ***Postage Paid***

RHAMSTINE★ RADIO FREQUENCY TRANSFORMER



$4.50

Complete with mounting

Its attractive appearance, its bayonet mounting, its ease of wiring as well as its efficiency and low price have made the Rhamstine★ R. F. Transformer a favorite everywhere.

Catalog describing all Rhamstine★ products will be mailed on request.

J. THOS. RHAMSTINE★
★Maker of Radio Products
2152 E. Larned St. Detroit, Mich.

PERFECT ELECTRIC CONTROL

RESIST-O-METER

TRADE MARK

With adjustable brackets for mounting.

Diameter 2⅜"
Depth from panel 1⅛"

Perfect Control of the "B" Battery

Type A—Filament
Price $1.80

Type B—"B" Battery
Price $2.00

We manufacture the following:

RESIST-O-METERS

Type A—Filament
Type B—"B" Battery
Type C—Potentiometer

TEST-RITE CONDENSERS in the following capacities:

Phone	.001	mfd.
Grid	.00025	"
Grid	.0005	"
Grid Leak	.0005	" 1-meg.

V. T. Sockets
Engraved Binding Posts
Accessories

A RHEOSTAT for finding the exact, correct voltage for the plate of your detector tube. Instead of trying to find the nearest correct plate voltage in 1½-volt jumps, use a type "B" Resist-O-Meter in series with your "B" batteries and you can adjust the "B" battery voltage until your vacuum tube will detect at its absolute maximum efficiency.

The type "B" Resist-O-Meter is a variable resistance, its range being from 50 to 25,000 ohms. To concentrate a variable resistance, which is continuously variable without jumps, in such a small space, is possible only by using the Rojas system of which The Scholes Radio & Manufacturing Corporation are the exclusive licensees.

Further information will be gladly furnished by requesting circular RM.

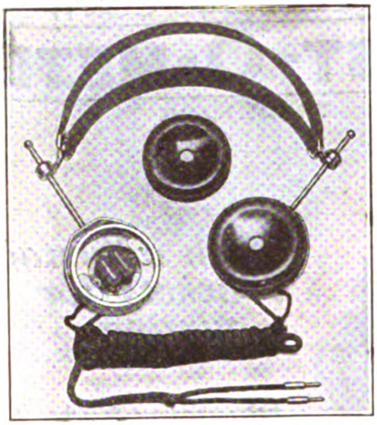
The Scholes Radio & Manufacturing Corporation holds the sole license to manufacture this type of current control, under patents granted Mr. F. A. Rojas, Nos. 15478 and 1366945, other patents pending. It is sold only under trade name "Resist-O-Meter." Ask your dealer to supply you.

Write Mr. C. W. Preston

The Scholes Radio & Manufacturing Corporation
32-36 West 18th Street New York City

RADIO

HEADPHONES



SENT ON APPROVAL

$8 LIST PRICE $8

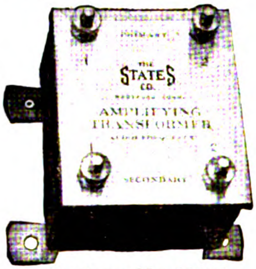
2,200 OHMS **LOUD AND**
LIGHT WEIGHT **CLEAR**

Dealers May Send
$3.20 for Sample

MONEY BACK GUARANTEE

FRENCH MFG. CO., Seymour, Conn.

A Recognized Standard Amplifying Transformer



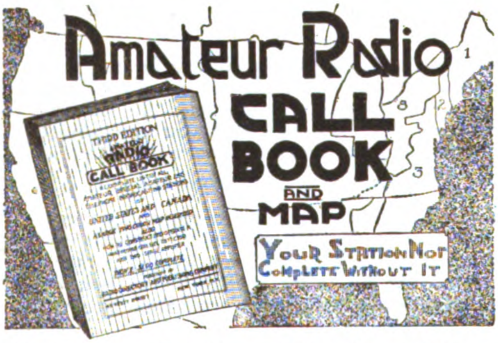
Catalogue No. 20001

Test voltage between primary and secondary and to core 1200

Price $5.00

Jobbers' and dealers' discounts

THE STATES CO.
Dept. C.
HARTFORD, CONNECTICUT


Amateur Radio
CALL
BOOK
AND
MAP
Your Station Not Complete Without It

The Book for Radio Fans

THE New Edition of the **AMATEUR RADIO CALL BOOK** is the most complete directory of amateur stations published to date —listing **Amateur, Special Amateur and Telephone Broadcasting Stations of the United States and Canada,** also describes the Construction and Operation of a Honeycomb Coil Set, Detector and Two Stage Amplifier.

THE RADIO MAP

OF the United States and Canada, size 2 x 3 feet, supplies an indispensable requisite of every radio station. The nine radio districts, broadcasting stations, standard time, areas, etc., etc., are clearly indicated.

Record Your DX Work

By pasting the map on heavy card board and using colored stick pins you can easily record your distant radio work.

At Your Dealer or Send Direct

PRICE book and map complete (DO NOT SEND STAMPS) **$1.00**

Dealers Write for Information

RADIO DIRECTORY AND PUBLISHING CO.
45—J VESEY STREET **NEW YORK, N. Y.**

DEPENDABLE TESCO LINE

INSTRUMENT MAKERS SINCE 1909

ANNOUNCEMENT

The Manufacturing of the

PRECISION HIGH EFFICIENCY

CRYSTAL SET

NOT A TOY

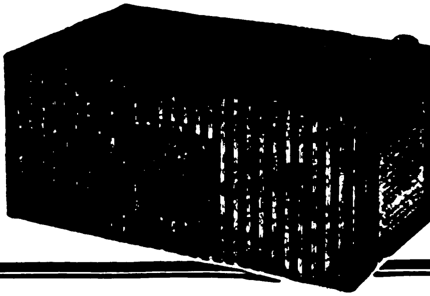
Guaranteed to receive local broadcasts with volume and clarity equal to any crystal set regardless of price

PRICE OF SET $1.25

WITHOUT PHONES OR AERIAL

Sent prepaid upon receipt of express or postal money order.
Money refunded if not absolutely satisfactory.
Dealers and Jobbers write for discounts.

THE EASTERN SPECIALTY CO.
3552 N. FIFTH STREET **PHILADELPHIA, PA.**



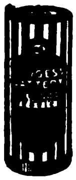
BURGESS

RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.



BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

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BURGESS

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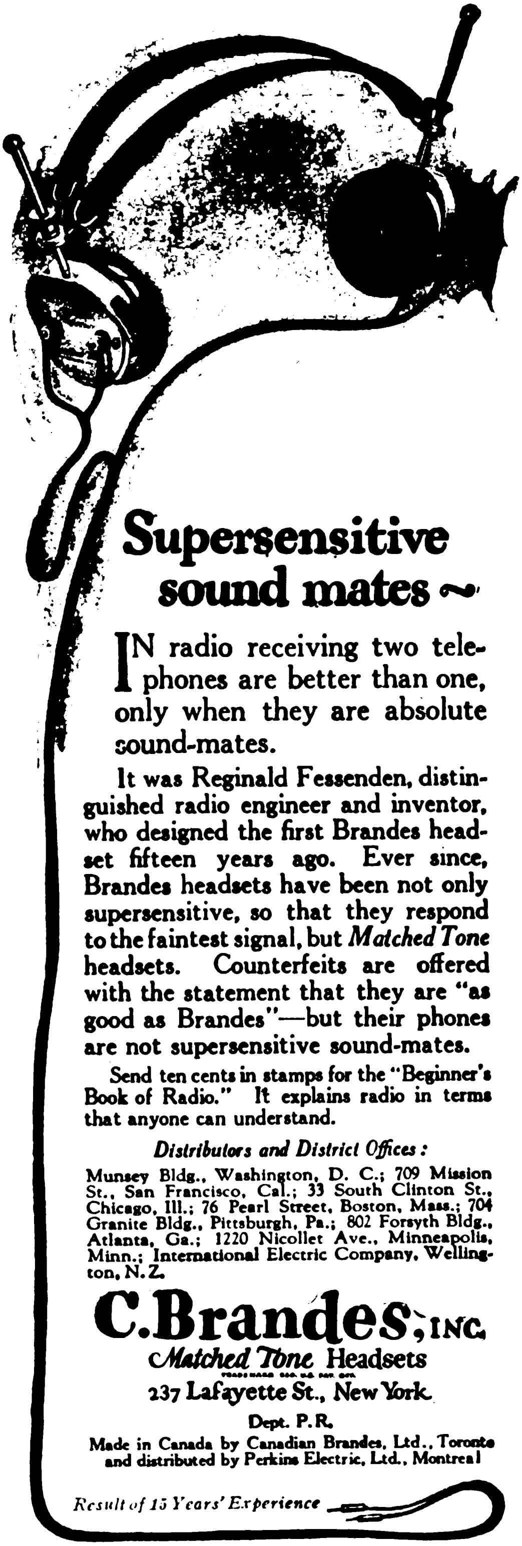
"ASK ANY RADIO ENGINEER"



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IN radio receiving two telephones are better than one, only when they are absolute sound-mates.

It was Reginald Fessenden, distinguished radio engineer and inventor, who designed the first Brandes headset fifteen years ago. Ever since, Brandes headsets have been not only supersensitive, so that they respond to the faintest signal, but *Matched Tone* headsets. Counterfeits are offered with the statement that they are "as good as Brandes"—but their phones are not supersensitive sound-mates.

Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

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C. Brandes, Inc.
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Dept. P.R.

Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric, Ltd., Montreal

Result of 15 Years' Experience

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SCREW the Dubilier Ducon into any lamp socket, and you hear the broadcasting station perfectly. No antenna or loop is required.

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The Missing Link in RADIO

Stops Interference!

Get rid of the interference that is spoiling your evening concert. By using the "WAVE TRAP" you eliminate it.

It is installed in a minute by changing only one connection, and is indispensable on any receiving set with any type of antenna. It is mounted on a formica panel in a handsome mahogany finished cabinet 6x5x6 and is a high grade instrument throughout.

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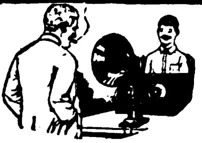

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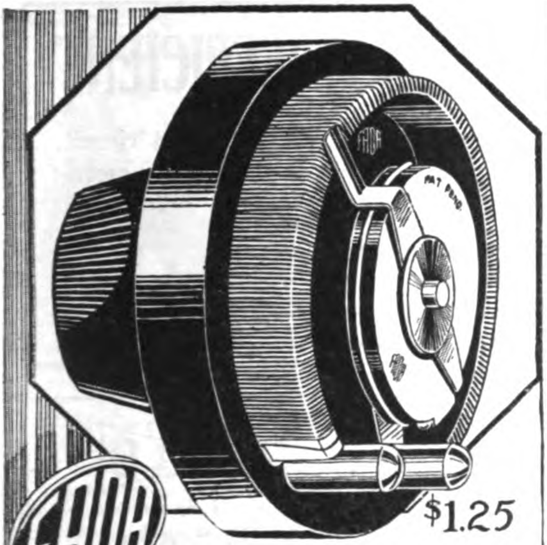

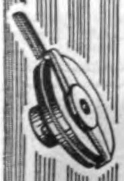

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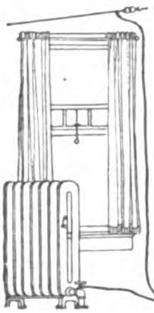
The last word in **RADIO**

Receiving Set *and* **Head Phone** ***Combined!***

HERE is the most unique "listening in" outfit in the field of Radio. *In the Etherphonette the receiving instrument is built right into the head phone.* No extra equipment is needed. Simply connect to single wire aerial (40 to 75 feet long) inside or outside the home or to lamp socket antenna plug, and ground to radiator, gas or water pipe. Then "tune in."

One shell of the Etherphonette contains a 1500 ohm phone—the other an efficient tuner and concealed crystal detector. Catwhisker, crystal and tuning controlled by outside adjustment knobs. A special eight-foot cord with five foot split ends, and clips for aerial and ground connections, completes the set. Entire Etherphonette is no larger and no heavier than ordinary head phone.

The Etherphonette is not a toy but a practical, scientifically built, radio receiving set. Receives any broadcasting station, sending on 200 to 450 meters, within 18 to 20 miles.



Price $12.50

If your dealer does not have the Etherphonette in stock order direct from us. We will ship complete Etherphonette parcel post, on receipt of check or money order, or C. O. D., if desired. Money back for your Etherphonette, if within ten days, you are not satisfied.

Order today—be the first in your neighborhood to get the unique Etherphonette.

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Manufacturers of
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99% EFFICIENT

ACTUAL SIZE

Every vacuum tube requires a different value of resistance in the grid circuit. The Durham Variable High Resistance provides a Variable Resistance by means of the plunger.

Type 100—Value from 1,000 to 100,000 ohms.
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BOTH $.75 EACH

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1936 MARKET STREET   Broadcasting Station W. C. A. U.   PHILADELPHIA

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Its costs nothing to investigate. Write me today and I will send you full particulars by return mail and place before you the facts so that you can decide for yourself.

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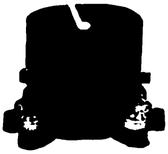

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V. T. Socket
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Moulded genuine condensite. Requires but small space for mounting. Readily accessible binding posts. No excess metal to interfere with efficiency. Unaffected by heat of bulbs or soldering iron. Phosphor bronze contacts. Nickel plated brass binding screws. Slash cut slot. Price possible because of large production.

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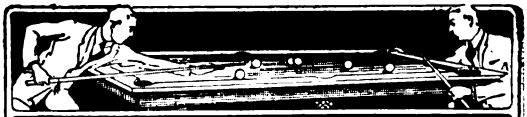

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ACME
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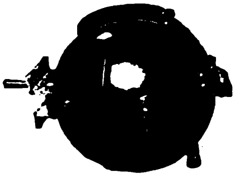
Kellogg Radio Equipment for Better Results

Easy to Mount—Simple to Operate

Variometer



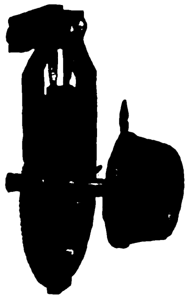
The stator and rotor are of Kellogg Bakelite, with properly proportioned windings of well insulated copper wire.

Two terminals are provided for the rotor and three for the stator, permitting the variometer to be used in all the known variometer circuits.

Kellogg variometers have no sliding contacts; nothing to wear or "short." A spring takes up all play and allows the rotor to turn with a smooth, even motion.

No. 501..........Each $8.00

Rheostat

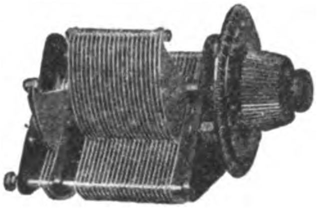


The Kellogg rheostat is of simple design, having but one moving part.

It is so arranged that a maximum contact surface is provided, making perfect contact. To assure perfect current to the most critical tube, the rheostat operates on the half turn of the resistance element.

No. 501............Each $1.50

Variable Condenser



The Kellogg variable condenser is of the decremeter type and is unusually well built throughout. A customer writes: "It is in a class by itself."

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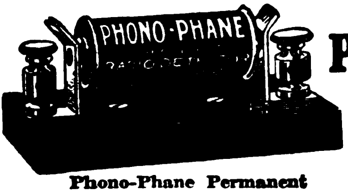

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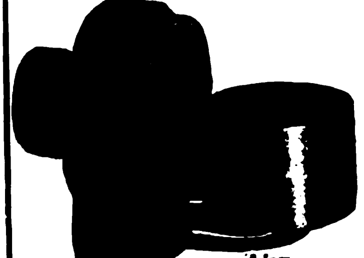
The only fixed radio detector requiring no adjustment. Used in place of crystal or vacuum tube detector. Gives excellent quality of sound without distortion. Detects telegraph signals at several thousand miles. Detects broadcasted music more clearly than vacuum tube detector, and requires no amplification where the incoming signal has sufficient strength to actuate the sensitive phones.

Handsome, substantial, suitable for assembly in the finest radio equipment. Guaranteed against imperfection or faulty operation. List, each.. $3.50



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THE name "Pruden" back of standard Radio Equipment is a guarantee of mechanical excellence, perfection of workmanship and scientific correctness of design.

Now, more than ever, when the market is flooded with inferior goods, it pays to buy standard trade marked products.

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Numerals engraved on bevel and knob so shaped that fingers do not hide them. Thin edge with clear graduation to make accurate reading easy. Concealed set screw in metal insert. Will not warp or chip. Finish and enamel permanent.

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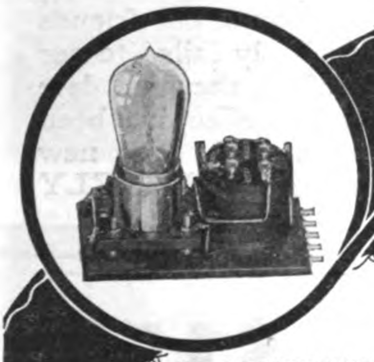
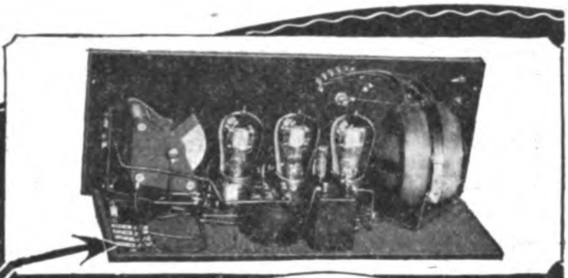
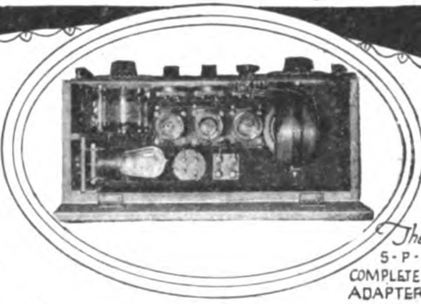
Demonstrated superiority against regenerative receivers, with list price of just $85. Popularity with public, growing in leaps and bounds, makes it the greatest seller on market.







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The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

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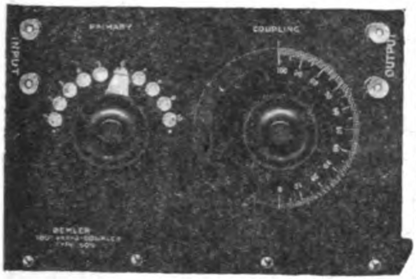

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Vario Coupler Price $12.00

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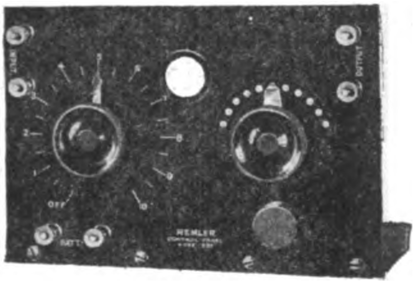
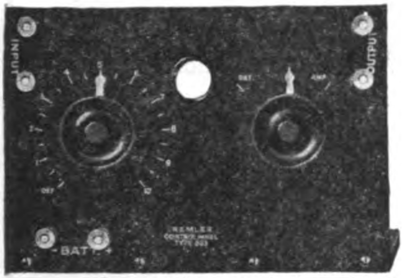


Remler Type 330 Detector
Panel Price $8.50



Remler Type 333 Amplifier Panel
less transformer Price $9.00

Remler Panels Make An Ideal, Economical Receiving Set

In placing these panels on the market Remler has put a high quality receiving set within the financial reach of everyone.

When designing these Remler panel-units, Remler engineers combined every point necessary for efficiency in receiving, together with special features of construction for the convenience of the user. No process of manufacturing that would make these panels efficient in operation, beautiful and uniform in appearance has been neglected. Each panel is a complete unit mounted on a hardwood base for table use but so designed that any number of panels may be easily mounted in a single cabinet.

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You can Start with only three panels:

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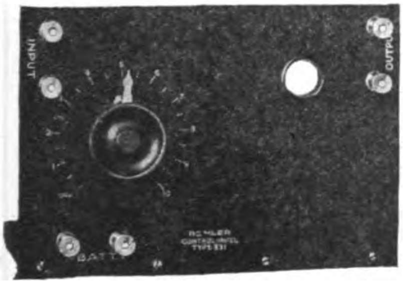
The diagram below shows five Remler panels connected to form a complete inductively coupled receiving set and two-stage Amplifier.

Send 10c for new Remler 40-page catalog giving prices and complete descriptions of every Remler article.



Remler Type 331 Amplifier Panel
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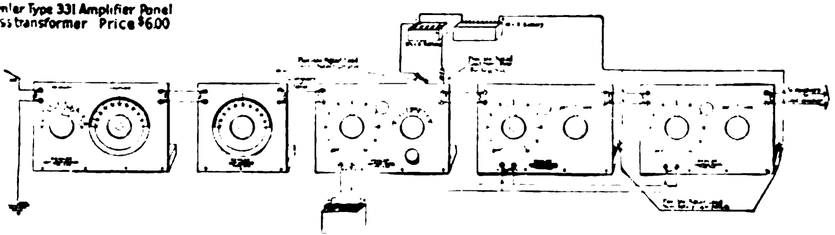

The Remler Technical Bureau is at your Service. Address your problems to Dept. O

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Two Inductance Coils Nos. L-1250 and L-1500

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If you don't see what you want here, write us. Perhaps you can send us a larger number of subscriptions to get still more valuable equipment. In that case we shall make you a special offer. Bear in mind there is an extra charge of $.25 for postage on each Canadian subscription, and $.50 for foreign countries.

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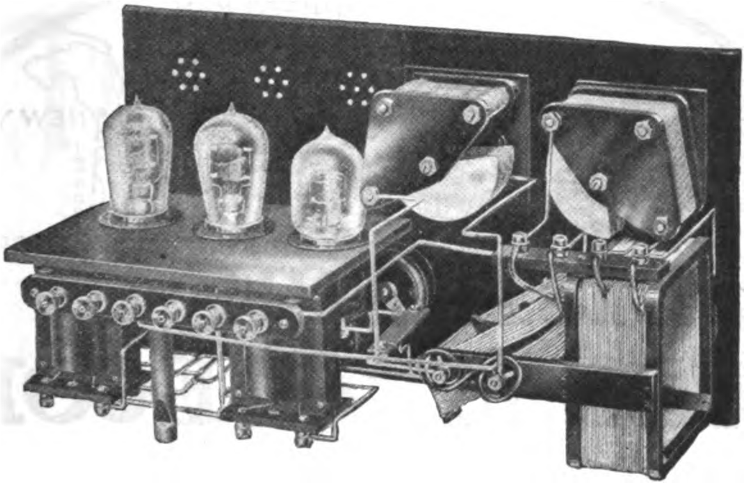

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After a thorough trial, and observation of other radio receiving instruments, I wish to state that the Crosley Model X is giving better results than anything else I have ever tried, not only in Sebring, but in Tampa and Jacksonville as well. We are receiving from all the standard stations, North, East and West, with the exception of the New England states, New York city being the farthest we have received in that direction. But we have received from a station announcing itself as Winnipeg, Canada, letters not plain, another from Seattle, Washington, and one night we received three selections and two announcements from KDYX, at Honolulu, Hawaii.

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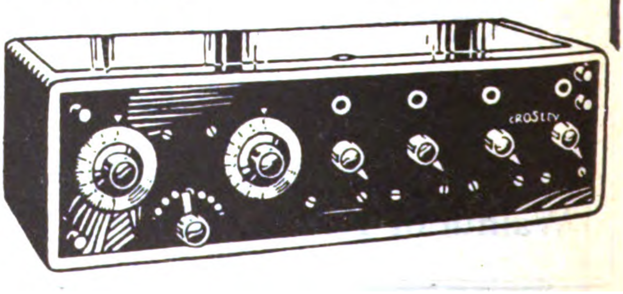

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List Price 60c.

Here is the cheapest vacuum tube insurance you can buy.

The Teleradio Tube Protector complete sells for 60c and extra fuses for 10c apiece. Not much to pay when you figure that each time you blow out a 10c fuse you save the price of a $5 or $6 tube.

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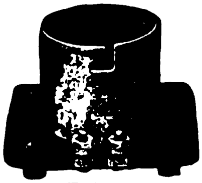

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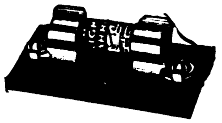

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**AMPLIFIES
AS IT
DETECTS**

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Give Clearest Reception

Cunningham Tubes used in any standard receiving set will enable you and your friends to listen to news reports at breakfast, stock market quotations at lunch, and in the evening sit in your comfortable living-room by the fireside and enjoy the finest music and entertainment of the day.

Send 5c for new 32-page Cunningham Tube catalog, containing detailed instruction for the operation of Cunningham Tubes as well as numerous circuit diagrams and graphic illustrations of tube action.

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Cunningham tubes are covered by patents dated 11-7-05, 1-15-07, 2-18-08 and others issued and pending. Licensed only for amateur or experimental uses in radio communication. Any other use will be an infringement.

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Super-Sensitive
DETECTOR
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TYPE C-301
Distortionless
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Popular Radio

MARCH 1923

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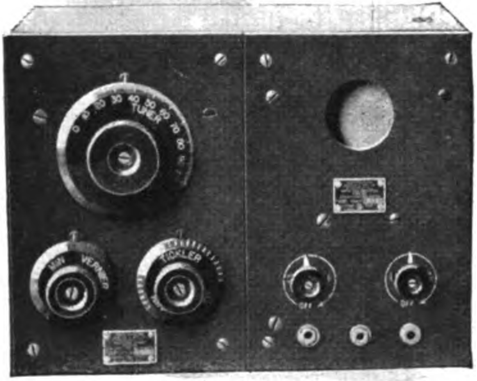

In TRENTON, he hears stations 1500 miles away with Radiola RC

REG. U. S PAT. OFF.

J. T. K. Hudnut, Secretary and Treasurer of the Trenton Electric Supply Company, recently wrote and said about Radiola RC:

> *"Just a line to tell you that Radiola RC has given perfect satisfaction. On Tuesday evening between 11.15 and 11.30 I picked up Chicago and Kansas City."*

This is but one of thousands of letters received in which owners of Radiola RC have commented on its remarkable range. Half the delight of radio lies in this ability to pick up the far stations.

Radiola RC is a compact, highly-sensitive, long-distance receiver that can be used with a loud-speaker to flood a room with music. Thousands of Radiola RCs are in use everywhere.

The price of Radiola RC is $132.50. Examine it at any RCA dealer. If there is none near you, write to us and we shall put you in touch with one.

To find out what Radiola will fit your needs and purse, write for free illustrated booklet "Radio Apparatus for Broadcast Reception."

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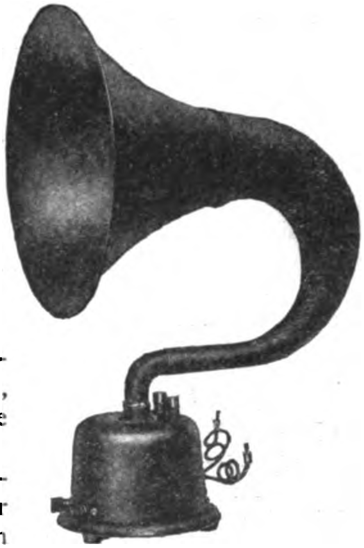
BRISTOL AUDIOPHONE JR.

Loud Speaker



For Radio-Phone Reception the AUDIOPHONE JR. is a strictly high-grade instrument, built to Bristol standard and backed by the Bristol reputation of 33 years.

The Audiophone Jr. is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set.

It is a true sound reproducer, bringing to home or public hall the distinctive qualities of the original performance. Characterized by its round, full, mellow tones—its ample volume—and freedom from blurring, mechanical distortion, and metallic effect. It has made radio a real source of restful, refreshing entertainment............**Price, $22.50**

The Audiophone Jr. can be used with any two or three stage power amplifying outfits. Where two stage amplification does not give the desired volume, the range of the Audiophone will be made ample by the addition of a Bristol One Stage Power Amplifier ....**Price, $25.00**

Bulletins on request—Demonstrations arranged for

THE BRISTOL COMPANY
Waterbury, Conn.

POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by William Edgar Fisher*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

"When happiness or calamity is about to come," said Confucius, "it can be known beforehand." Insure complete radio happiness with a Grebe Receiver.

Doctor Mu.

IF YOU buy inferior radio apparatus you must not expect the best results.

Its long record of satisfactory service has won for the Grebe Receiver the unqualified endorsement of all experienced radioists and dealers.

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A PAGE WITH THE EDITOR

THE two foremost radio scientists of New England—Prof. R. A. Fessenden, said to be the "first man to transmit the human voice by radio," and Dr. G. W. Picard, who holds more patents on the crystal detector than any inventor in the world—are now included among the distinguished contributors to POPULAR RADIO. That these two eminent experts should select this magazine as the medium for the important announcements that they will make during this year is both a tribute of which the Editor is not insensible as well as a rare treat to our readers.

* * *

EVERY radio amateur in the country knows Hiram Percy Maxim and Paul Godley—perhaps the two most popular radio fans in the world and certainly two who are of monumental help and inspiration in the development of amateur radio. It is with peculiar gratification, therefore, that the Editor presents Mr. Maxim's article on page 188 of this issue, and Mr. Godley's article on page 202. The latter (familiarly known among the fans as "Paragon Paul") supplements his article by a personal letter in which he states:

"POPULAR RADIO *is doing a real service. Everyone is always glad to help those who are of service.*"

The Editor may be pardoned if he accepts this commentary as "praise from Sir Hubert"—who, according to legend, was the than-whomest of complimentors.

* * *

THE broadcasting of the present series of Philharmonic Orchestra concerts in New York—a project initiated by POPULAR RADIO—is bringing to light some "human interest" touches that are worth more than casual comment. And not the least interesting of them is the fact that Henry Hadley's old mother up in Massachusetts is enabled for the first time to hear this great orchestra play when her son conducts!

* * *

"I BUILT the 2 variometer, 1 variocoupler set described on page 210 of the November POPULAR RADIO," writes Charles J. Adolph of New York, "using 100 feet of braided antenna wire strung in back of the picture moulding. I received all local stations and the following stations; WOC, WGR, WGY, KDKA, WWJ, WQAA, WDAP, WMAM, WHAS, WLW, and WMAF. Using my outside aerial I have reached as far as Fargo, North Dakota."

"If you see it in POPULAR RADIO *it's so!"*

* * *

As evidence of the efforts which the Editor is making to give our readers the best and only the best, it may interest them to know that in order to obtain pictures of Sir Oliver Lodge (for use as illustrations of his series of articles now running in POPULAR RADIO), we commissioned the foremost portrait photographer of England, E. O. Hoppé, to make a special trip of hundreds of miles to Sir Oliver's laboratory in Amesbury. That he was eminently successful in his quest is proved by the example of his work on page 211. The Editor regards it as the best photograph ever made of Sir Oliver.

* * *

ONE of the most important uses of radio (and the Editor is not so sure but that it may prove to be the most important use of all) lies in the field of education. The possibilities of bringing real education—"the world's greatest scientists and the world's greatest music"—into the Little Red Schoolhouse and into American homes are only beginning to be realized by a small number of universities which are experimenting with "extension courses" that are being broadcast for the benefit of the people of half a State. POPULAR RADIO, which has emphasized the importance of this phase of radio from the beginning, is particularly glad, therefore, to have the National Radio Chamber of Commerce take up the campaign and co-operate with us in establishing radio as an educational force more far-reaching than any the world has ever known.

* * *

SCHOOLDAYS—so far as this Editor is concerned—were long regarded merely as raw material out of which elderly but forgetful composers made sentimental songs; certainly he never classified them exactly under "Pleasure." It is with particular gratification, therefore, that he finally wheedles his first word of praise from an old teacher, Thomas M. St. John, who once viewed with patient alarm the efforts of the Editor to acquire an elementary knowledge of physics.

"I find that the articles in POPULAR RADIO are written in an offhand, readable manner that appeals to me," he writes from East Windham, N. Y. "I must confess that it is a mighty good magazine—even if you *are* the Editor."

* * *

ON March 20 the yearly subscription price of POPULAR RADIO will be $2.00 a year—as already announced.

To help every subscriber to take advantage of the present low rate of $1.50, our Subscription Manager is inserting in this March number an order blank that will enable each subscriber to get the magazine at the low price for just as long a period in advance as he desires. But his subscription must be paid not later than March 20.

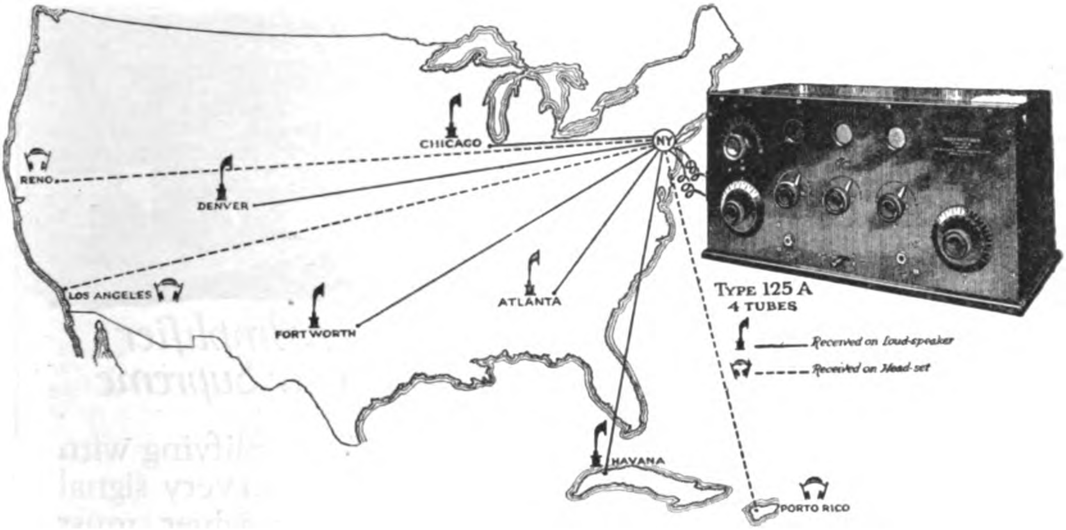
Don't forget the date!

Kendall Banning

Editor, POPULAR RADIO

CARDWELL PRODUCTS

Quality Radio Apparatus



Distance—Selectivity—Ease of Adjustment

CARDWELL RADIO APPARATUS is being used by the United States Navy, United States Signal Corps, and Bureau of Standards. The same rigid rules of manufacture and inspection are enforced in the production of amateur apparatus as in our Government and commercial work.

Cardwell Products include

Receiving Sets
Amplifiers
Condensers

Transformers—Audio
Transformers—Radio
Couplers

Descriptive Catalogue Mailed on Request.

—THE IDEAL RADIO FREQUENCY HOOK-UP—

This will be sent free of charge to those who wish to build an exceptionally fine set. An exceptionally good hook-up embodying long range and selectivity.

OUR INSTRUMENTS STAY SOLD

The Allen D. Cardwell Manufacturing Corp.

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This combination completes any
RADIO
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MAGNAVOX Radio

The Power Amplifier and Reproducer Supreme

THE Magnavox, in amplifying witn extreme sensitiveness every signal supplied to it from the receiver, must necessarily amplify any extraneous sounds which may originate in the receiver or power amplifier itself.

Therefore, the *combination* of Magnavox Reproducer with Magnavox Power Amplifier (as illustrated) is very desirable. By this equipment, in connection with a good receiver, you get the music or speech with true clearness—and in practically any volume required.

To own a good receiving set without Magnavox equipment, is like having your house properly wired and then using only small, feeble candle-power lamps in the sockets!

R-2 Magnavox Radio with 18-inch horn: this instrument is intended for those who wish the utmost in amplifying power; for large audiences, dance halls, etc.

R-3 Magnavox Radio with 14-inch horn: the ideal instrument for use in homes, offices, amateur stations, etc.

Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Radio. 2 and 3 stage.

When you purchase a Magnavox product you possess an instrument of the highest quality and service.

Magnavox products can be had of good dealers everywhere. Write us for copy of new illustrated booklet.

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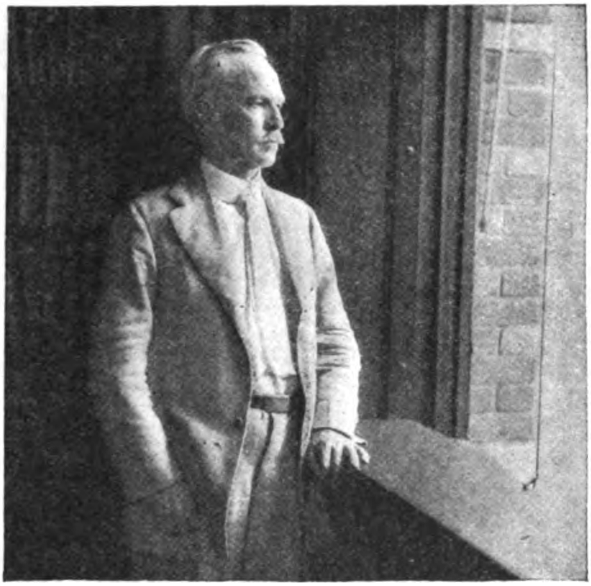


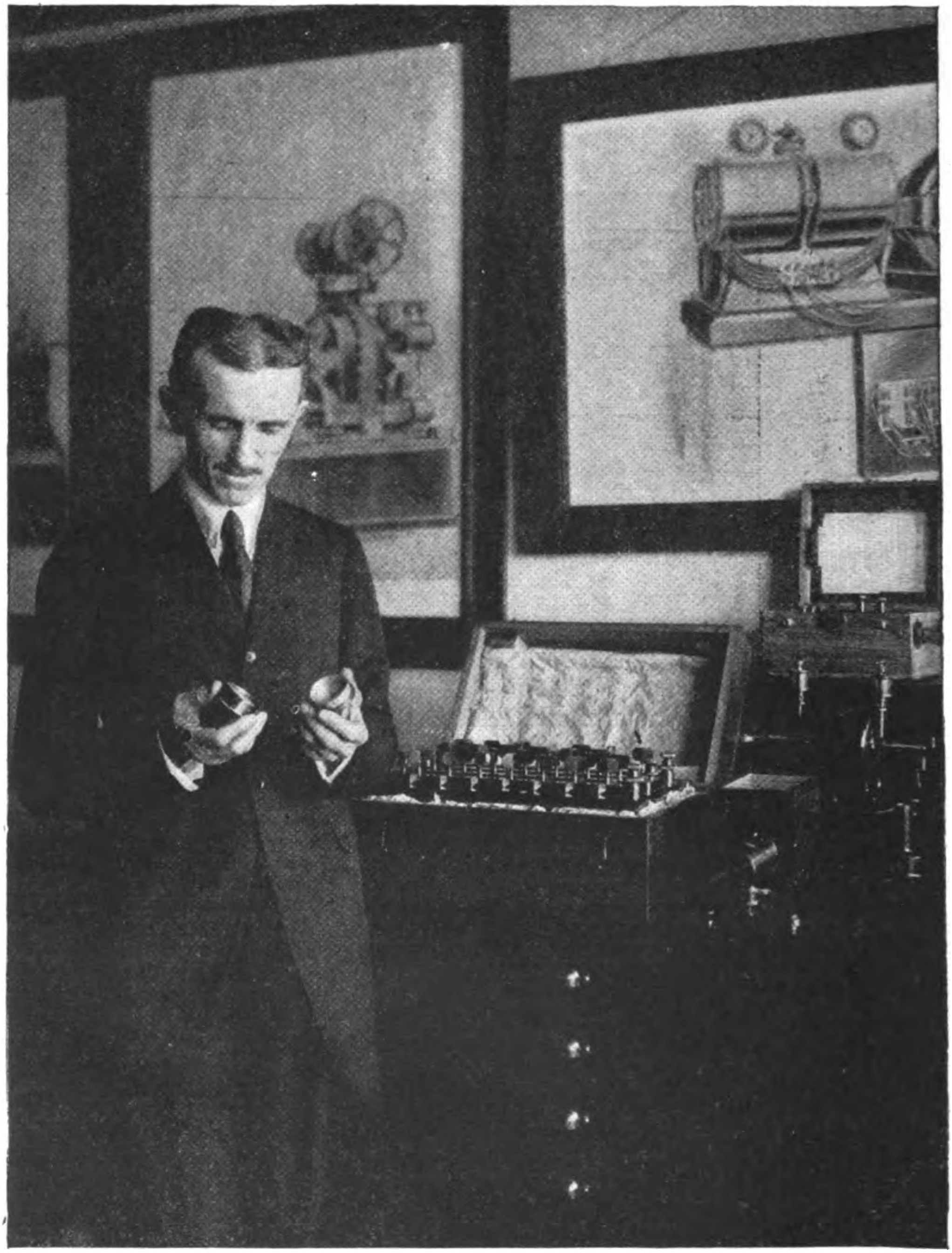
Radio—the Most Far-Reaching of Educational Agencies

To the Editor of Popular Radio:

I think you are profoundly right in your belief that the vital need now in the interests of radio is a provision for worth-while programs. Your plan for this sounds feasible. If you can bring it to pass you will have initiated an educational service that may conceivably become more far-reaching than any other educational agency, and of inestimable value to the culture of the Nation.

David Kinley

President, University of Illinois



From a photograph made for POPULAR RADIO

"Power Can Be and Will Be Sent by Radio"

Such is the statement of Nikola Tesla—one of the most imaginative geniuses among the great inventors—whose spectacular experiments with high frequency currents twenty-five years ago established him as a world-known figure. He is the inventor of the induction motor and of the coil that bears his name.

Popular Radio

VOLUME III MARCH, 1923 NUMBER 3

The Motion Picture Speaks

How the long-cherished dream of inventors to make the "movies" vocal has at last been solved by the radio experts, who are converting sound successively into electric current, light waves, pictures, electric current and back again into sound.

LEE DE FOREST, Ph. D., D. Sc.

TALKING movies are an accomplished fact. Perfect synchronism of speech and action has been attained, and this success is another triumph for that wonder worker of radio, the audion amplifier. The talking movie depends upon the use of the tubes to amplify the minute electric currents with which it is necessary to work and it is no exaggeration to say that the vocalization of the motion picture would never have been accomplished at all were it not for the fact that the motion picture technicians had available to them the perfected inventions of the radio engineer.

The earlier attempts at talking movies, fiascos which we all remember so well, depended upon schemes for connecting together an ordinary phonograph and an ordinary motion picture machine. The phonograph was supposed to repeat a certain sound at the exact instant that the appropriate action took place on the screen. To make the two machines run precisely at the same rate there were complicated arrangements of governors and regulators. In one of the processes, for instance, small holes were punched at intervals in the film. Compressed air escaped through these holes much as it does through the holes in the paper roll of a piano player and this escaping air was supposed to regulate the speed of the phonograph so that it would play its record at a rate exactly equal to the rate of progress of the film.

None of these devices worked very well. Not only were there delicate mechanical or electrical adjustments which frequently got out of order, but there was another difficulty, one which would be entirely unforeseen, probably, by anyone not actually experienced in the motion picture business. This was the disturbance of the record caused by breakages of the film.

Once in a while when you are watching the pictures in a motion picture theatre you will see the picture suddenly disappear, leaving a blank white screen. This means that the film has torn in two. The young man in the projection room does a little fast work and presently the picture goes on again as though nothing had happened. But before that particular film can be used again its torn ends have to be trimmed off so that they are even and then stuck together again with film cement. This makes the film an inch or two shorter than it was before.

So far as the picture is concerned, this shortening makes no great difference. There are sixteen separate snapshots to the foot of film and the loss of one or two of them is not even perceptible when the film is projected. But suppose that the film is one which has been carefully synchronized with a phonograph record. If you leave out an inch or two of film the sound record gets behind the action by just that much. After three or four breaks have been made and fixed you will hear the sound of a fall, for example, a second or two after it has really happened. It will sound like an echo.

It is not possible to avoid occasional breakage of the film and this was the reason why experienced motion picture engineers were always rather sceptical of any scheme for mechanically synchronizing films with phonograph records. What was needed, they thought, was some way of recording the sound record on the film itself so that the sound record and the sight record would be synchronous and inseparable automatically.

This is exactly what the new talking movies are. In my process, for instance, which I call the "Phonofilm process," the record of the sounds is registered in the form of a narrow strip of lighter and darker hairlike lines running crosswise, at the edge of the film, like the rungs of a tiny ladder. This record is produced at the same time that the pictures are taken, by a photographic process. When the film is run off these sounds are reproduced.

The "photographing of sounds" is new only in details. Scientists have been photographing sounds for many years and by half a dozen different processes. The beginning of the story takes us back to 1879 and to Dr. Alexander Graham Bell, the inventor of the telephone.

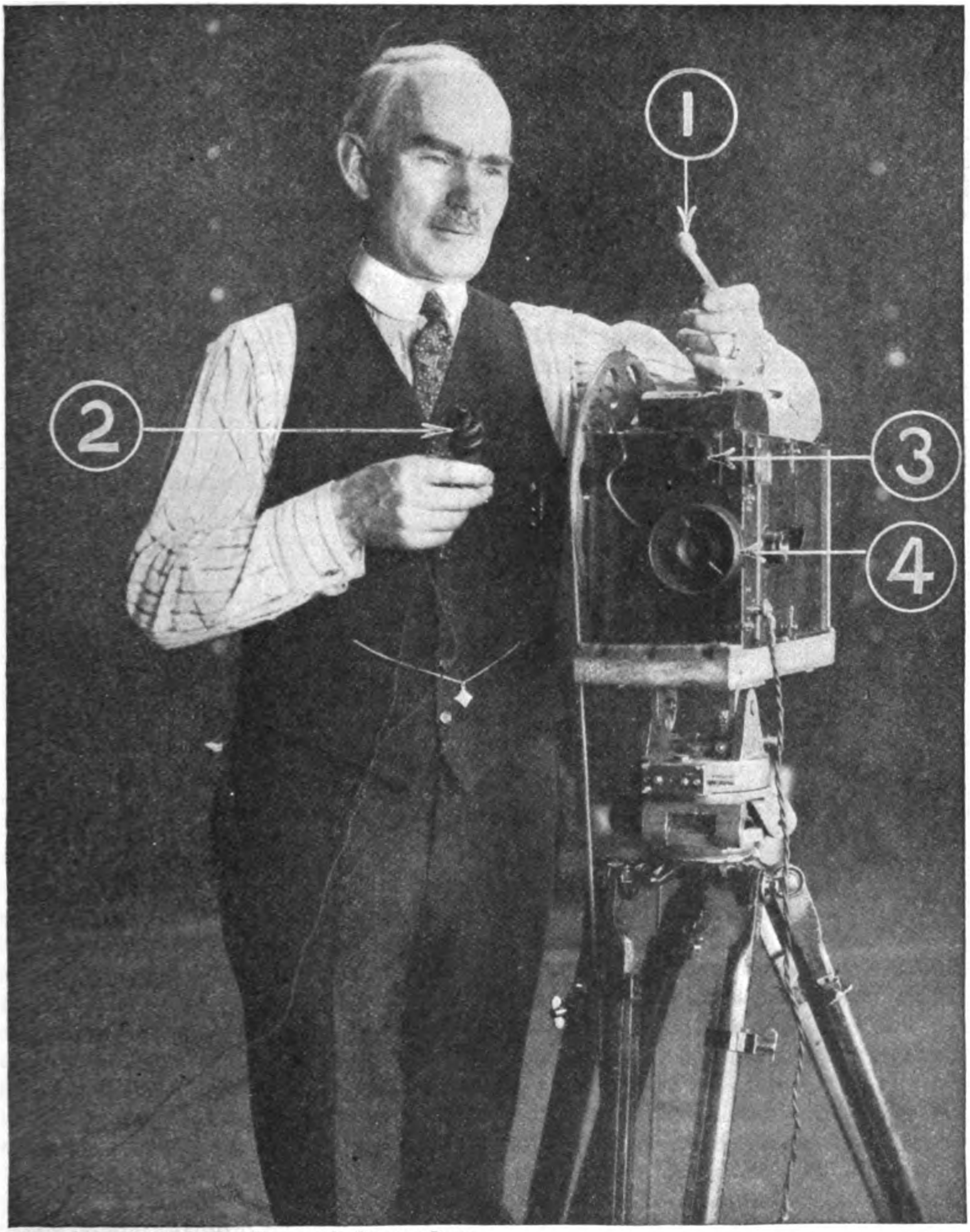
When Dr. Bell was working out the telephone he gave a good deal of attention also to other ways of transmitting speech. Perhaps the telephone might turn out a failure and some different device might have to be substituted. Among other things he tried out a way of talking along a beam of light. One day in 1879 he stood in his garden and actually talked for over two hundred yards along a beam of sunlight reflected from a little mirror which he held in his hand.

The secret was in the mirror. It was made out of very thin glass and it was not perfectly flat. Instead it had a slight spherical curvature as though it had been cut out of the side of a very large globe of glass. The beam of light was reflected from this curved surface.

Back of the mirror was a mouthpiece into which Dr. Bell spoke so that the sound waves of his voice struck against the back of the mirror. These waves made the mirror vibrate just as the diaphragm of a telephone vibrates when you speak into it. And when the mirror vibrated its curvature changed, it became alternately a little flatter and a little more curved. This affected, of course, the amount of light reflected from its front surface. The beam of light fluctuated in strength and these fluctuations were found to correspond exactly to the sound waves, which were beating against the back of the mirror-diaphragm, just as the electric currents in a telephone transmitter correspond to the sound waves which strike against its diaphragm.

Dr. Bell's device was really a telephone in which a mirror took the place of the usual transmitter and a ray of light took the place of the electric current in the wire.

In 1879 there was no particular use for such a device. The motion picture was still a dream. The electric telephone proved to be successful and the light-telephone—Dr. Bell called it a photo-



From a photograph made by Paul Thompson for POPULAR RADIO

The Camera that Records Both Action and Speech

For the benefit of the readers of POPULAR RADIO, *Dr. Lee De Forest is here demonstrating his new and remarkable invention. He is inserting the "photion" (1) into its proper socket. This photion (coined from the words "photograph" and "audion," meaning literally an audion that takes photographs) is the secret of the phonofilm machine. The microphone that receives the voice is shown at (2); the opening (3) leads into the chamber that contains the apparatus that converts sound into light waves. (4) is the regulation shutter equipment used on every motion-picture camera. The records of both motion and sound are thus recorded on the photographic film.*

phone—dropped out of sight. He did not attempt to photograph the sound waves.

But might not such a device have its use in war? The Germans thought so and in 1890 they financed the investigation of one Ernst Walter Rühmer on this same problem.

Rühmer did not use a mirror. He selected a totally different principle, the principle of the electric arc. He used an ordinary old-fashioned arc lamp, in the circuit of which was a microphone. When he spoke into the microphone, the sound waves affected it and it, in turn, affected the brightness of the arc; producing fluctuations which corresponded, as in Dr. Bell's device, to the pulses of the sound. This fluctuating light from the arc Rühmer sent out in a searchlight beam miles across the country to a receiving station where its pulses could be converted back again into audible sound.

During the war the Germans revived and improved this old method of Rühmer's. An apparatus devised by Dr. H. Thirring is said to have been in use at times on the Western front. Many a searchlight beam watched incuriously by our scouts as of no importance may have been carrying light-borne words which our intelligence department would have enjoyed hearing. But Dr. Thirring's work was not known until after the armistice and the possibility that a photophone was being used went unsuspected.

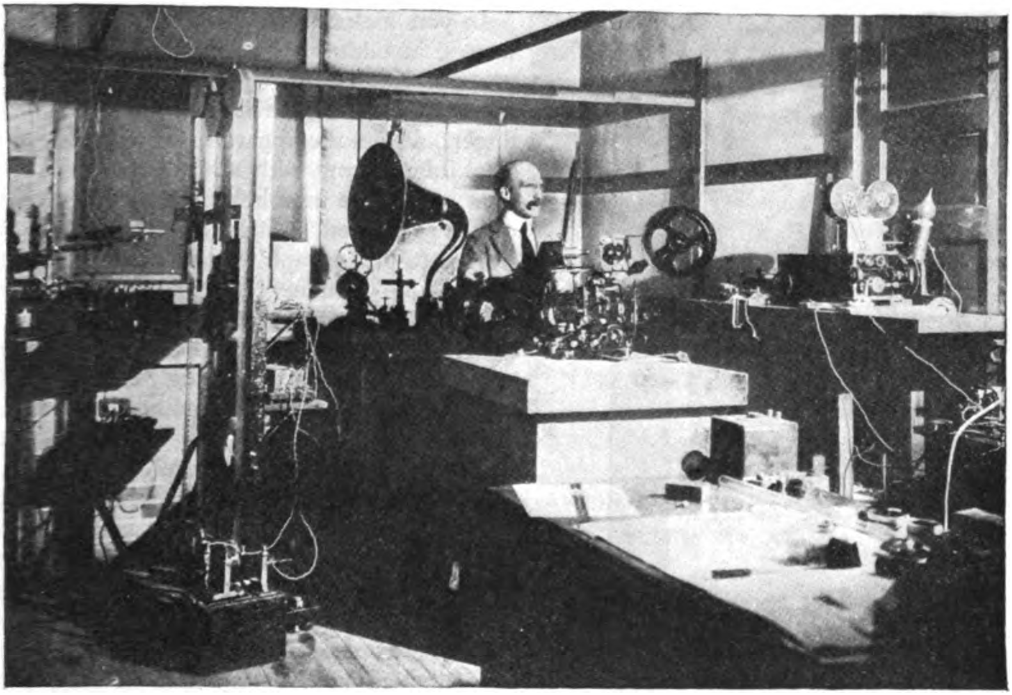
The British Admiralty, however, were working along similar lines, though for a different purpose. They were seeking a method of telephoning between ships at sea. Dr. A. O. Rankine, the distinguished physicist who conducted their investigations, did not use the arc method. He used a vibrating grating attached to a diaphragm, like that used years before by Dr. Bell and was so successful that he was able to talk for a distance of eight miles over a beam of sunlight only six inches in diameter. The familiar heliograph used in all armies and navies to exchange dot-and-dash signals by means of a beam of sunlight became capable of serving as a telephone as well.

None of these things had any immediate application to the movies. Even in 1918 no one seemed to see that these new war inventions contained the answer to the old problem of how to make the movies speak.

The first person to see this connection, or the first, at least, to actually make it effective, was Bergland in Sweden. Early in 1921, he exhibited to a group of scientific men a machine in which sound was recorded by means of a moving spot of light reflected from a tiny mirror. Sound waves were made to vibrate this mirror, and the mirror vibrated just as Dr. Bell's mirror did, but it was arranged so that the vibration took the form of back-and-forth swings instead of changes in curvature. These swings made the little spot of reflected light move back and forth across a moving photographic film, and the result was a wavy line photographed on the film. The waves in this line, the ups and downs of it, were found to correspond exactly to the pulses of the original sound. From this line the sound could be reproduced.

According to the published descriptions of it, Bergland's original machine was merely a sound recorder. It produced a record of sound just as a phonograph does but it recorded this on a strip of photographic film instead of a disk or cylinder of wax. In applying his invention to the making of a talking motion picture Bergland used two films side by side. One film received the picture just as it does in an ordinary motion picture camera. The other film received the wavy line which was the sound record. As the picture was taken the two films were moved forward by the same shaft. In this way, Bergland undertook to obtain exact synchronism between the two films.

But it is reported that he did not.



THE LABORATORY OF A DOCTOR WHO IS A "VOCAL SPECIALIST" ON FILMS

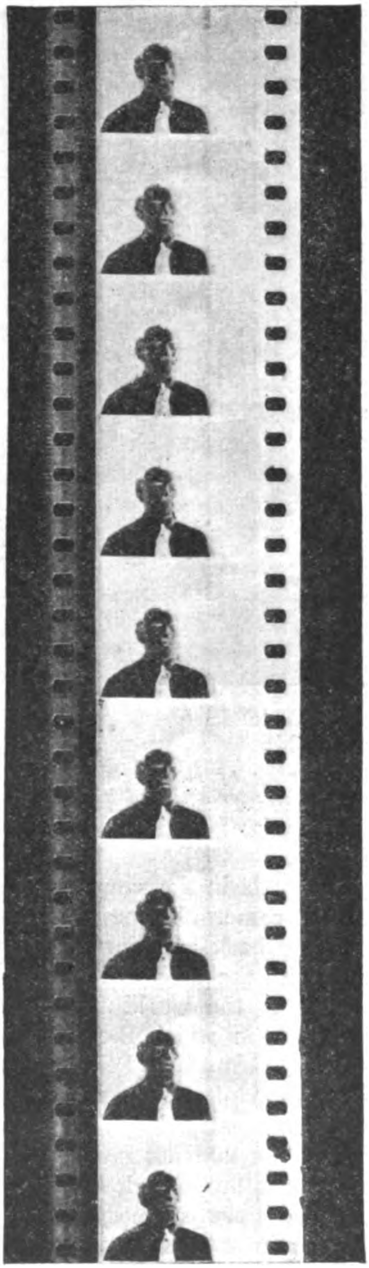
The workroom of Prof. J. T. Tykociner, of the University of Illinois, who has developed a talking motion picture film that uses a special shutter actuated by sound waves instead of the moving mirror or photion on which Dr. De Forest's invention depends.

Motion picture film always shrinks and changes a little as time goes on. Separate pieces of it do not always shrink equally. Then the holes in the margin of it, into which fit the teeth of the sprocket arrangement which moves the film, sometimes wear a little larger, so that the motion of the film is not quite uniform. These difficulties and others like them, it is said, interfered with the perfect agreement of Bergland's two films. It was necessary, or highly desirable, to put the two records actually on the same single strip of film.

Even while Bergland was working in Sweden this last step was being taken by another inventor in England. Only a few weeks after the Bergland tests Mr. Grindell Mathews announced the perfection of a camera which photographed the wavy line of the sound record and the successive pictures of the scenic record actually on the same film. The sound record was made in the same way as in the Bergland camera, by means of a tiny mirror swung back and forth in correspondence with the waves of sound.

This gave to the world for the first time a process in which the sound and the picture could not help being synchronous, since both of them were recorded on the same film strip.

It might seem that not much could be added to this but in developing the phonofilm we have succeeded, I think, in improving in at least two particulars any of the previous processes for a speaking film. The first of these improvements is what we believe to be a better way of photographing the sound. The second is an improvement in a part of the apparatus which I have said nothing about so far, the part which translates the sound photograph back again into real sounds which we can hear.



A STRIP OF TALKING FILM
(Actual Size of Negative)

This negative was made by Dr. De Forest's new phonofilm process. The hairlike lines of the right of the strip of sprocket holes on the left is the record of sound. During projections, a beam of light passes through this record onto a photo-electric cell and converted first into an electric current, amplified by vacuum tube amplifiers and finally reconverted back into sound by means of a loudspeaker.

If you look inside the camera which we use in taking the phonofilm the only unusual thing you will see is a small glass tube about the size of your little finger. When the apparatus is operating, this tube glows with a brilliant violet light. It is the new invention, which we call the "photion." It is the thing which we use to photograph sound.

The tube contains a special mixture of gases which it took me over three years of experiment to perfect. When an electric current is passed through the tube, this gas mixture becomes luminous. It is the gas which produces the violet glow.

Perhaps you have seen lately some of the neon-filled glow lamps which are being used to attract attention in stores and shop windows. A tube of bent glass, often shaped into words or letters, contains a little of this neon gas, about one thousandth of one per cent of which is contained in ordinary air. When a high frequency electric current is sent through this neon-filled tube, the gas glows with a soft reddish light which is pleasant and attractive. The photion works on much this same principle. Of course, the gas in it is not neon and the glow is violet, not red. But it, too, is a gas glow excited by an electric current.

If you watch carefully the glow of a photion in operation you may be able to see that the light is not absolutely constant. It flickers a little. Pulses of greater brightness alternate with brief instants when the glow is a trifle dimmer. This means that the photion is translating sound into light. The rapid flickers and pulses which you see mean that you are literally seeing speech.

The photion tube is excited by a high frequency electric current, modulated by the voice in exactly the same way as in a small radio-telephone transmitter. This part of the apparatus is in fact identical with the radiophone transmitter.

In the electric circuit which operates the photion and which causes it to glow we insert a highly special substitute for the microphone and one or more vacuum tubes as amplifiers. This ground receiver picks up sound waves and converts them into pulses of electricity. The electric pulses, after being amplified sufficiently, control the radiophone which is exciting the glowing photion and affect its light. The flickerings of this light, its rapid brightenings and dimmings, correspond exactly to the waves of sound which enter the microphone.

This shows you how the phonofilm process transforms sounds into light; but how does it photograph them, how do we secure a permanent record of them on the motion picture film?

This is how. The glowing photion is in a little chamber by itself inside the camera and this chamber is light-tight except for one tiny slit only one millimeter long and a fortieth of a millimeter wide. The moving film on which the motion picture is being taken runs past the photion chamber in such a position that the edge of the film passes just under this slit. The light from the photion streams through the slit and is photographed on the film, making the strip of tiny hairlike lines already described; a darker line for each instant when the photion is brighter, a less dense line when the light of the photion is a little more dim.

This little ladder of lighter and darker lines is our photograph of sound, our answer to the problem of recording successfully both the sight and the sound. The width of the sound photographs is always the same. The *intensity* of the light, and that alone, is varied by the sound. This feature distinguishes the phonofilm from all other methods, and permits a more faithful reproduction of every light and shade of sound than is otherwise possible. And by this photion or phonofilm method, it is seen, there is complete absence of any mechanical moving parts, nothing in the entire system up to the final diaphragm of the loudspeaker which can introduce a natural period of vibration of its own, tending to distort the original sound, in record-

From a photograph made by Paul Thompson for POPULAR RADIO

A SCIENTIST WHO UTTERS SPEECH THAT WE CAN SEE

Dr. De Forest—best known to radio fans as "the man who put the grid in the radio bottle," or in more scientific terms, the inventor of the audion or three-element vacuum tube—is here revealed in his laboratory inspecting a motion picture film that records both the movements of his lips while speaking and also the sounds that issue from them. Long before the advent of the vacuum tube, however, Dr. De Forest was experimenting with "wireless" telephony; many old-timers among the radio amateurs of New York recall the thrilling experimental days when his squeaky and distorted voice-tones, transmitted by arc and high-frequency spark telephones, filled the ether with early promises of the marvels that were to come. The square box at the inventor's elbow, with the small circular opening, contains the new type of microphone especially developed for the talking films.

ing or in reproduction. So far as the taking of the movie is concerned, this is the whole of the story.

But how is one to get this back into real sound again? How is the sound record on the film to be reproduced when the motion picture is run off in the theatre?

Consider first what the problem is. The taking of the talking motion picture involved two successive conversions of one kind of vibration into another kind. First the waves of sound were converted into electric waves by the microphone. Next the electric waves were converted into light by the photion. Now we must do these same two things in reverse order. On the finished film is our little ladder of darker and lighter lines. A ray of light can be made to shine through this ladder and the strength of the light that gets through will correspond to the lines on the ladder. As each dark line passes across, the light transmitted will be momentarily dimmer. This gives us, to start with, what we finished with when the movie was taken, namely, a light which flickers in exact correspondence with the waves of sound. The problem is to convert these flickers back again into real sound.

Most of the previous investigators and inventors have made this light-sound conversion by means of the metal selenium, a metal which has the property of changing its electrical resistance when light rays fall on it. But no one was satisfied with selenium. It was too erratic and undependable, too slow in recovery.

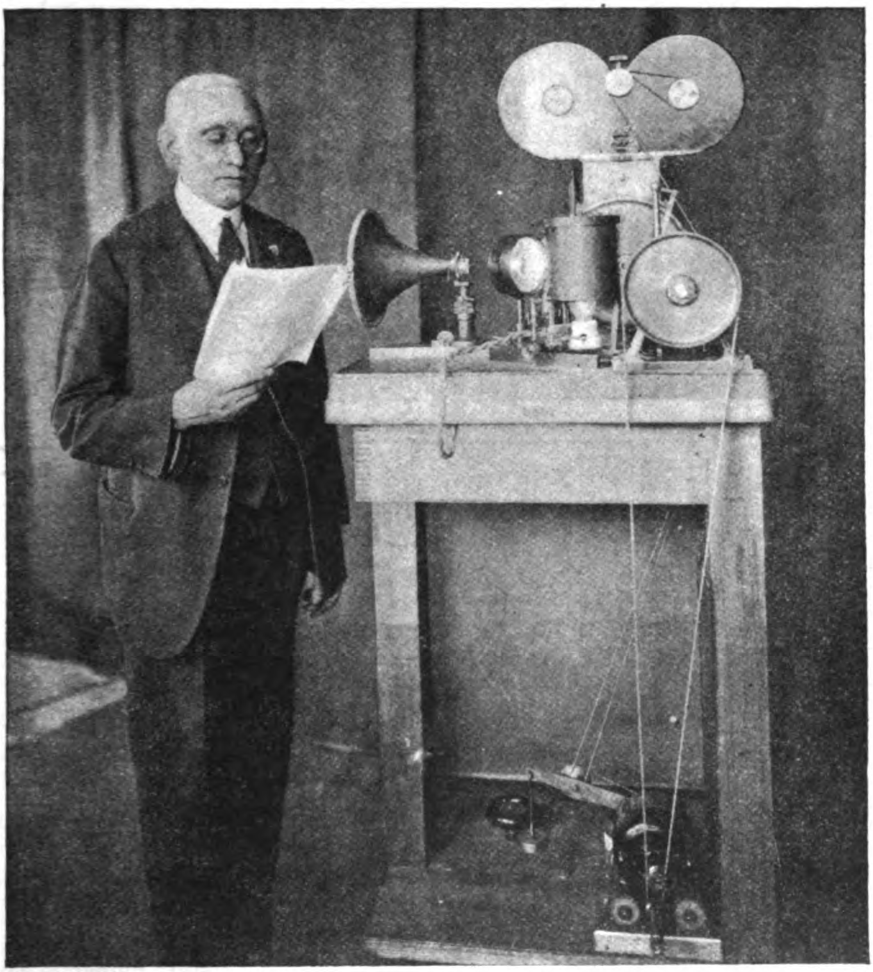
Years ago the same Dr. Hertz who discovered the waves now used in radio made another discovery. He discovered that plates of certain metals gave off electrons when they were illuminated. Every radio fan knows that the filament of a vacuum tube gives off electrons when it is hot. Dr. Hertz's metal plates did the same thing, only they did not have to be hot. All that was necessary was that light of some kind should be falling on them. This discovery was the beginning of the photoelectric cell.

In modern forms of the cell, the metal plate which is to give off the electrons is in a vacuum inside a sealed glass bulb. It looks a good deal like a glass egg with two short glass tubes about the size of lead pencils sealed into it, one at each end. The light shines into this egg from one side. On the other side, facing the light, is the plate of the sensitive metal, usually of the rare metal potassium or the still rarer one, rubidium.

When hit by the light the metal gives off electrons and the number given off a second changes with the strength of the light. The more light, the more electrons. You see at once what the pulsating light which shines through the sound record on the film will do. It will cause the electron emission inside the photoelectric cell to pulsate also. More or fewer electrons will be given off in exact correspondence with the sound waves which were originally photographed on the film.

This makes the first of the two conversions which we saw to be necessary, the conversion of the light pulses into electric ones. The next conversion, the one into real sound, is made in the usual fashion by amplifier tubes and a special telephone. The electron current in the photoelectric cell is feeble, but even one tube will amplify it until it will operate a telephone. Four or five tubes will make it strong enough to operate a loudspeaker and fill the largest motion picture theatre.

This gives you the whole process. Suppose we are taking a motion picture in which, let us say, Buster Keaton falls downstairs. For each step there is a bump and the sound wave of each bump makes a little flicker in the glow of the photion. This flicker records itself on the little ladder of lines which is being photographed on the film. Wherever that film goes, whatever is done with it, there is the record of Mr. Keaton's bump side by side with the view showing just how he came to make it.



General Electric

HE PRODUCES SOUND BY MEANS OF A VIBRATING MIRROR

What is in effect a motion picture photograph of the human voice, reproduced in the form of a graph that records vibrations, is the invention of Dr. Charles A. Hoxie. His machine is called the "Pallophotophone," and it not only "photographs" sound but reproduces it with most amazing clarity and power.

Then some day the film is shown in a theatre. The light of the projection machine shines through one of the pictures and shows a visual image of Mr. Keaton's downfall. At the same instant another light shines through the sound record. This light sees, so to speak, the sound image of Mr. Keaton's bump. It carries this image on to the photoelectric cell. The cell instantly transforms it into an electron image of the sound of the bump and hands this on to the audion amplifier. The amplifier strengthens it into a greater sound and hands it on to the loudspeaker which lets out, in its turn, a loud bang and we who sit, watching and listening, hear the misfortunes of Mr. Keaton at the same instant that we see them.

And at *exactly* the same instant! For all these changes and conversions happen with almost inconceivable rapidity, with the speed of electric currents which come close, most of them, to the 186,000 miles a second which is the speed of light.

From the special viewpoint of the

Courtesy of J. E. Williamson

THE FIRST MAN TO TRANSMIT SOUND ON BEAMS OF LIGHT

Back in 1880 Dr. Alexander Graham Bell invented the "photophone," by means of which speech was transmitted 200 yards on a ray of sunlight reflected from a curved mirror. In the picture above the good doctor is revealed as a diving Bell; it was snapped while he was emerging from the Williamson submarine tube in the West Indies, shortly before his death.

radio engineer there is one particularly interesting aspect of these various conversions of vibrations between light and sound and electricity. It is that they constitute a kind of modulation just like the modulation of continuous waves of radio telephony by sound waves.

Light is, of course, an electromagnetic wave just like the radio waves except that its wavelength is very much shorter, or, in other words, its frequency is tremendously higher. Instead of the frequency of about 800,000 a second which characterizes the ordinary broadcasting wave, light has frequencies measurable only in quadrillions a second, wavelengths defined in millionths of a millimeter.

Now in ordinary radio telephony the modulation consists merely in superimposing the low frequency waves of sound, which have from 20 to about 5000 vibrations a second, onto the moderately high frequency waves of the continuous wave radio. The sound wave goes out, one might say, as a passenger on the radio wave. Similarly, in the phonofilm, the function of the photion is to superimpose these same low frequency waves of sound first onto the higher frequency waves of the radio telephone and then onto the still higher frequency waves of light. The passenger is the same but is traveling on a different train, a train of much shorter cars. In ordinary radio modulation we speak of "audio" frequency and "radio" frequency. In these new light conversions we must speak of audio frequency in relation to what we may call "photo" frequency, this being the tremendously high frequency of the waves of light.

And just as there are various ways of producing the modulation of radio frequency by audio frequency, so there are various ways of superimposing sound waves on light. The photion is one of these ways. The mirror methods of Dr. Bell and of Dr. Rankine are others. The arc method of the Germans is still another. And two other methods, two newer ones, have been announced within the past year in the United States.*

And now what does this mean for the movies? Granted that a real talking movie can be produced about which there now seems little doubt, will this cause any serious change in the present methods of producing motion pictures and of presenting motion picture plays?

The motion picture experts do not agree in their answers to these questions. Most of them seem sceptical. They do not expect, they say, any immediate public favor for a talking movie no matter how perfect it is. The reason they give is a psychological one.

The essence of a successful motion picture, they say, is their ability to create an illusion. The images on the screen do not look exactly like the actors. They are just a jumble of black and white masses and lines and dots. Our favorite stars look lifelike to us because we have become used to this. We recognize the lights and shadows of the screen as symbols, much as the multitude of little black lines and dots and curves on this page are recognized by you as symbols of letters and words and thoughts. This page would not be so recognized by a savage who did not know the symbols of our alphabet.

And without illusion of reality which the mind makes for itself out of the symbols on the screen, motion pictures would have, these experts believe, much less interest and emotional appeal.

Now suppose you combine these visual screen symbols with sounds. The sounds are symbols also. They too must create their illusion. Will they reinforce the eye symbols or will they interfere with them? Most likely, say the sceptics, the result will be interference, not reinforcement. It is easy, they think, to create one illusion at a time, either an eye illusion or an ear illusion. It is much less easy to create both at once and to have them fit into each other in the mind. And so, they think, the path of progress for the talking movie is not going to be altogether smooth.

Perhaps not, but this is little likely to deter inventors from following it. We believe that we have already in the Phonofilm a device of great utility in scientific investigations and in the making of speech records side by side with pictorial ones, for instance in making records of important events. Whether the motion picture experts will adopt it for purposes of public entertainment we are content to leave to them—and to the future.

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*One of these methods is that of Professor J. T. Tykociner of the University of Illinois. This, too, has been applied to the making of talking movies. In place of the moving mirror or the photion, Professor Tykociner uses a special mercury arc lamp. The light of this lamp, modified in intensity by the vibrations of the sound, falls onto the moving film, where it is photographed to make a strip of shaded lines not unlike the record on the Phonofilm.

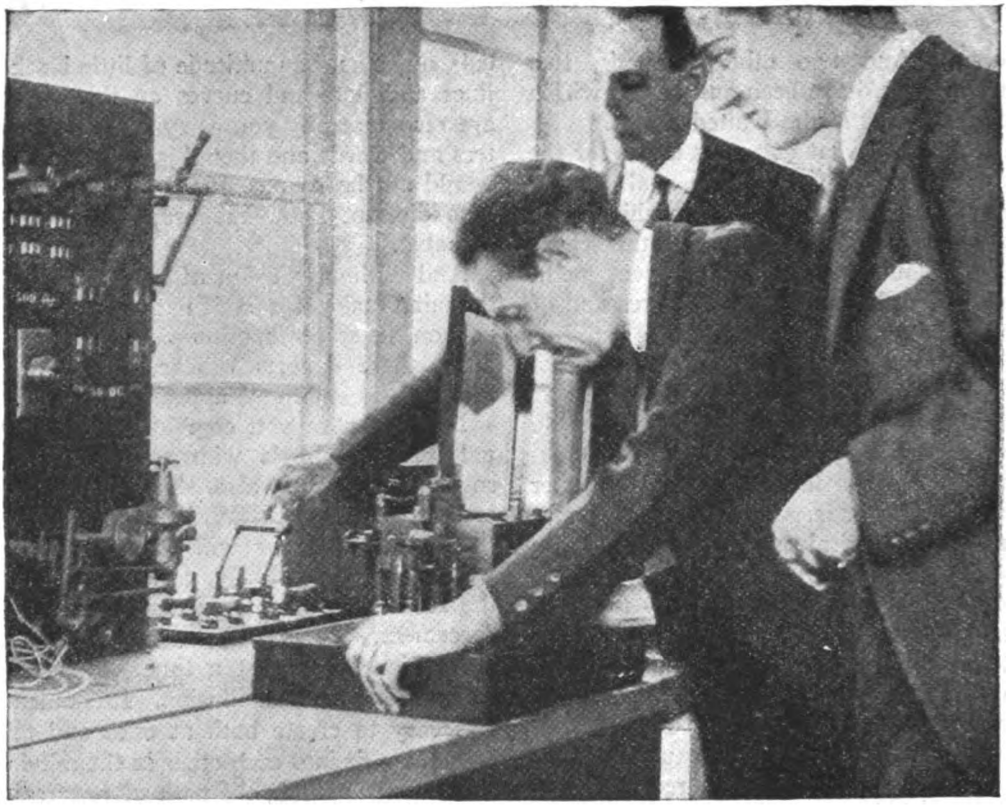
The other new method has been announced by Dr. Charles A. Hoxie of the Research Laboratory of the General Electric Company. His device appears to depend on a moving mirror, which would make it an improved form of the method used by Bergland in Sweden and by Mathews in England.

In all of these methods, the curved mirror of Dr. Bell, the arc of Rühmer and Thirring and Tykociner, the shaking mirrors of Rankine and Bergland and Mathews and Hoxie, and in the photion, the result accomplished is the same. It is the superposition of an audio frequency signal on photo frequency waves of light.—EDITOR.

Seeing by Radio

By WATSON DAVIS

IT is at present possible—as every well-informed amateur knows—to transmit pictures *via* wireless by several more-or-less successful processes. When the art of thus transmitting "still" pictures has been speeded up, the next step obviously will be to transmit motion pictures; perhaps even to transmit scenes direct from life! How this conception may become a reality is something more than hinted at in the remarkable invention of C. Francis Jenkins. An exclusive description of the Jenkins apparatus will shortly appear in POPULAR RADIO, illustrated with special photographs that show its operation together with specimens of the pictures as they are received.



A REAL MAKER OF MODERN "MIRACLES"

While John Hays Hammond, Jr., has been actively engaged in many lines of scientific experimental work at his laboratory near Gloucester, Mass., he is principally known to the public through his stirring demonstrations of radio-controlled vessels, torpedoes and aircraft—a development of radio that promises to have profound effects upon our civilization in both war and peace. He is here shown in the act of directing by radio the movements of an un-manned yacht in the harbor.

A PLAN FOR A PAY-AS-YOU-ENTER

RADIO NET

By JOHN HAYS HAMMOND, JR.

The recent demonstrations, initiated by Popular Radio, of the possibilities of broadcasting events of importance by means of the "pick-up" system, points the way to what appears to be a logical development in radio—so far as general broadcasting on the ether is concerned. Such a method of broadcasting requires the installation of land wires between the auditorium or field where the events are held and a distant radio station. In this article Mr. Hammond proposes a plan for restricting this broadcasting service to subscribers only, by "narrow-casting" (by means of wired wireless) along the telegraph, telephone or electric light wires or along power cables. Mr. Hammond's project is, in effect, a restriction of the "pick-up" system of broadcasting to that section of the public who may pay a toll charge to the telephone, telegraph or power companies or to other public service corporations that may be willing or able to develop a system for undertaking such a venture on a profit-making basis.—Editor.

MY idea of a complete, nation-wide broadcasting system is this:

That the present copper line equipment of the United States, owned by such companies as the telephone and telegraph organizations, should participate in the general problem of broadcasting.

• Only at the termini of these lines should there be erected radio broadcasting stations of moderate power to cover the rural districts. Thus, where radio became necessary, it would be used, but the ether would not be used for any unnecessary transmissions. This is an important fact in view of the increasing demand on the single line ether conductor furnished to us in radio transmission.

The distribution of news could, for illustration, be classified thus:

1—General international news.
2—Financial and market news.
3—Congressional and legislative news.
4—News from the various scientific and advisory departments in Washington, such as the Agricultural Department, the Bureau of Standards, the Weather Bureau, and others.
5—Transmission of music.
6—Educational news in the form of lectures.
7—Commercial and advertising news.

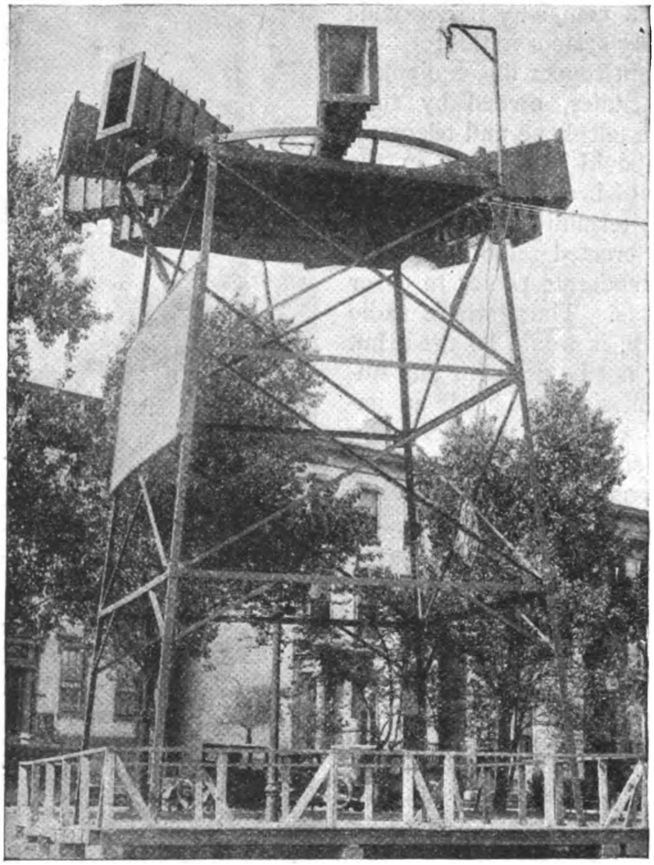
The bulk of this news could be initiated from various centers such as New York, Chicago, San Francisco and other important cities. This news would be segregated and carried by voice on the lines by the present carrier multiplex telephone system, and specific frequencies could be allotted to each of the seven classes specified above.

From Washington would originate information concerning the activities of our political representatives. The desks of the various members in the House and Senate could be equipped with transmitters under the control of operators in the galleries of these chambers. The name of the speaker could be

Westinghouse

"THE NEWSPAPER THAT COMES THROUGH YOUR WALLS"

News items, stock quotations, weather reports—these are but a few of the features of our daily papers that are already being broadcast regularly by the large stations. Will "narrowcasting" along telephone, telegraph, electric light and power cables develop such a service for subscribers only?



International

BY MEANS OF THIS HUGE AMPLIFIER AN ENTIRE TOWN HEARD PRESIDENT HARDING SPEAK

The inevitable expansion of radio broadcasting will make it possible for entire communities to listen to the deliberations of Congress—to say nothing of other events of national or international importance. This remarkable apparatus was installed near Cincinnati, Ohio, in order that the President's address at the great centenary celebration could be heard over a radius of a mile.

announced by the operator in the gallery and the particular transmitter opposite the speaker could be switched in momentarily by the operator. His voice could then be carried back to his constituents even in the distant sections of the country. Thus the centers of legislative action could be constantly in personal touch with the people of the country—a situation that would, I believe, have a profound effect upon some of the methods of Congressional debate, and would lead eventually to modifications of congressional procedure.

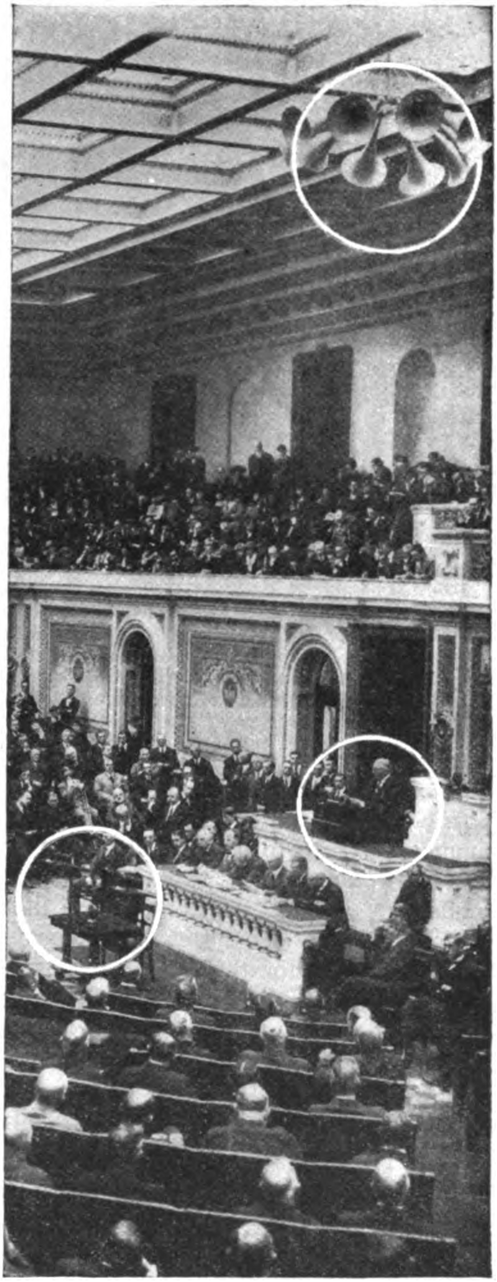
By such an installation of radio equipment at the Capitol it would be possible for the President to address an audience numbering millions of people on occasions when he gives voice to proclamations of nation-wide interest. The political importance of such a system would not leave Washington cold.

Through the great network of the telephone lines news could be switched or concentrated upon, or disseminated to any part of the country. The millions of present telephone subscribers would find their telephone not merely a limited instrument, as it now is so far as intercommunication is concerned, but a source of educational interest and pleasure. They could, for example, by calling up their local central, ascertain what news was being transmitted under the various headings referred to, and the central by switching to any one of these frequencies could obtain for the subscriber whatever news was desired and bill him at the prescribed rates. Urgent calls could be put through promptly; the numbers of other calls could be recorded by the central and given to the subscriber at the conclusion of the news transmission.

Passing on from the telephone subscriber, the news would be transmitted over the lines to terminal points, where it could be converted into radio-telephone transmission. We will imagine for purposes of illustration that one of these points would be some outlying town that has certain local interests. The long distance news transmitted from New York and Washington would come through for broadcasting, but there would also be added at this point another frequency which would carry the local advertising and general local news. This, then, would be broadcast by radio over a range of a few hundred miles covering all the rural districts in this section. It would be possible for people marooned in an Iowa snowstorm to hear a lecture in New York City or the Metropolitan Opera or legislative debate on the floor of Congress, agricultural advice from Washington headquarters or the status of the stock market. The rural subscriber who depends upon the reception of programs by radiophone would be equipped with a foolproof receiver; he would be given a standard form of antenna, some instruction as to the handling of the equipment and the service and attention of certain company engineers who would occasionally have to look over the radio equipment.

The multiplex messages carried over the lines would be easily modified into the multiplex form of radio transmission.

I know that from the technical point



National Photo

A HISTORIC MOMENT IN THE HISTORY OF RADIO

When President Harding appeared before the 67th Congress at the opening of the 4th session, his speech was picked up by microphones, conveyed by wire to the naval radio station at Anacostia (NOF) and broadcast for all to hear who would. The horns attached to the ceiling amplified the President's voice in the auditorium.

From a photograph made by Westinghouse for Popular Radio

THE EAR OF A MILLION LISTENERS

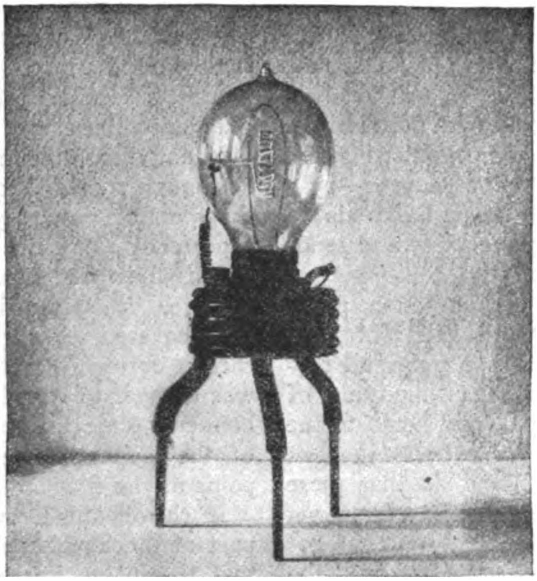
No longer is the audience at grand opera, concerts, lectures and other public gatherings limited to the handful that can crowd into a hall. By means of the "pick-up" system of broadcasting, the people of a half dozen States may listen in. The picture above shows the installation of the microphone at the Century Theatre, New York, when the concerts of the City Symphony Orchestra were broadcast from WJZ—a project initiated by Popular Radio.

of view the plan that I am suggesting is possible of realization. I believe that the monetary return to be derived from this system would make it eminently worth while as a practical project. I think that the present telephone system can be made a more vital factor than it is in the affairs of the nation, and it seems to me that radio is the logical means of infinitely extending the use of the line system for purposes of broadcasting.

There is still a large part of the population of the United States that is severed from direct connection with important centers of industry and progress. Great areas of the country sparsely settled are now to a great extent out of touch. Such a scheme of broadcasting as I propose would, I believe, be a powerful factor in unifying the interest and general sentiment of this great nation, and in national emergencies such a system would give the Government an unprecedented guidance in the trend of public opinion.

The Influence of Radio on Warfare

The rapidly extending use of radio during the closing stages of the World War, not only in establishing lines of communication but also for controlling engines of destruction, indicates a line of development that is destined to have a profound effect upon military and naval science. An important article on this subject is now in course of preparation for Popular Radio by one of the world's foremost military authorities, who is at present engaged in the compilation of data that will establish his work as a real contribution to the literature of radio.



THE ANCESTOR OF THE MODERN AUDION

Here is the original "Fleming valve." It consists of a carbon filament enclosed in a glass vessel with a second wire or electrode inserted between the filament leads.

HOW I PUT THE ELECTRONS TO WORK IN *The* RADIO BOTTLE

The Evolution of the Famous "Fleming Valve"—Told by Its Inventor

The wonders of radio are made possible by the vacuum tube—the modern "Aladdin lamp." This article describes how an apparent scratch on a bit of discolored glass led to a discovery from which the present science has grown.

By PROF. JAMES AMBROSE FLEMING, M. A., D. Sc., F. R. S.

AN aeroplane is speeding along at a hundred miles an hour, two miles up in the sky above the English Channel. A slender wire trails out behind the machine. From time to time the pilot glances at the compass on the instrument board.

Suddenly a voice speaks to him, the voice of a man sitting many miles away in his office in the city of London, a voice that has overtaken him.

The pilot listens, turns a switch, and answers. He is detached from earth, hurtling through space, but it is as though he were standing in that city office talking to his director.

This is one of the miracles of today brought to pass by a lamp. Another aeroplane speeds like a blind thing in a fog. The pilot can see nothing. He is quite lost, everything is blotted out, yet he has no fear. A tiny lamp has the aeroplane on an invisible leash, and leads it safely to the aerodrome.

Somewhere on the illimitable ocean is a battleship. An admiral in Whitehall, faced with a sudden emergency, desires to find that ship, speak with the captain, and send the grim ironclad steaming full speed to a secret destination. A few years ago it would have been an impossible task; now, a lamp accomplishes the miracle.

A ship is going down with hundreds of helpless passengers. An agonized signal for help is flung into the heavens—by a lamp. And another lamp, hundreds of miles away, instantly responds and sends a ship to the rescue.

A world-famous prima-donna pours out her soul in song in a little room, and the magic lamp takes her song and carries it from her lips to thousands of homes where people sit and listen to the thrilling cadence of her voice.

It seems almost incredible that these wonders are made possible by a lamp, yet it is true.

The story of how I came to invent the Fleming thermionic valve, which played so important a part in bringing these things to pass, began long ago when Edison was devoting his genius to lighting the homes of the people with electricity. After countless experiments the labors of Edison in the United States and of the late Sir Joseph Swan, aided by Mr. C. H. Stearn, in England, turned a scientific theory into an accomplished fact, and produced the electric incandescent lamp which was destined to work such wonders in the world.

Forty years ago, early in 1882, after the Edison Electric Light Company of London was formed, I was appointed electrical adviser to the company. I was therefore brought into close touch with the many problems of incandescent lamps and I began to study the physical phenomena with all the scientific means at my disposal. Like everyone else, I noticed that the filaments broke easily at the slightest shock, and when the lamps burned out the glass bulbs became discolored.

This discoloration of the glass was generally accepted as a matter of course. It seemed too trifling to notice. But in science it is the trifles that count. The little things of today may develop into the great things of tomorrow.

I wondered why the glass bulb grew dark and I started to investigate the matter. I discovered that in many burned-out lamps there was a line of glass that was not discolored in any way. It was as though someone took a smoked glass, drew a finger quickly down it, and left a perfectly clean line behind.

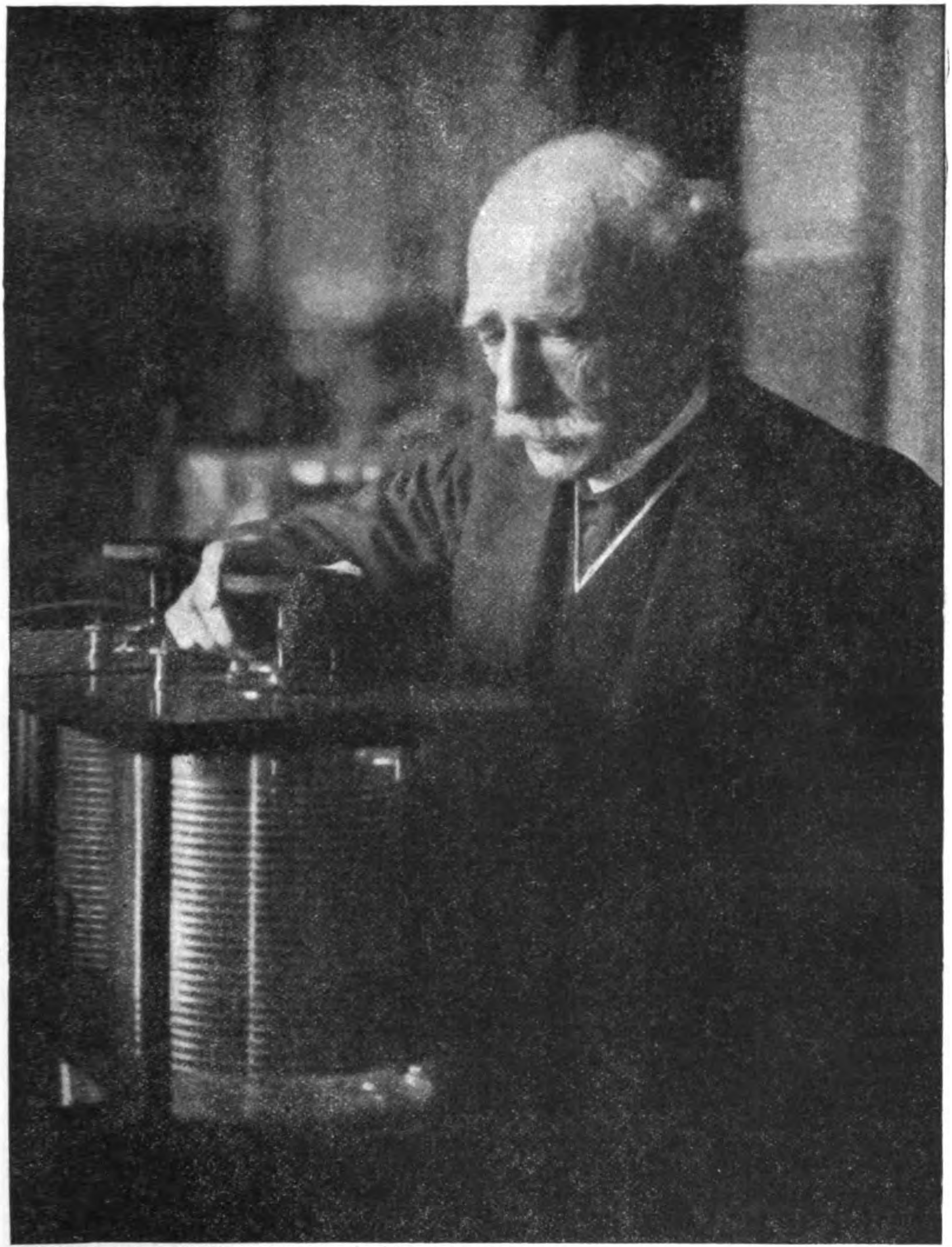
I found that the lamps with these strange, sharply-defined clean spaces were covered elsewhere with a deposit of carbon or metal, and that the clean line was immediately in the plane of the carbon horseshoe filament and on the side of the loop opposite to the burned-out point of the filament.

It was obvious to me that the unbroken part of the filament acted as a screen to that particular line of clear glass, and that the discharge from the overheated point on the filament bombarded the remainder of the bulb with molecules of carbon or vaporized metal shot out in straight lines.

My experiments at the end of 1882 and early in 1883 proved that I was right.

Edison was at work in his laboratory in 1883 when he noticed that if he fitted a tiny metal plate inside the bulb of an electric lamp and connected it outside the bulb with the positive end of the filament, he obtained a slight current. The phenomenon was called "the Edison effect"; but Edison could not explain it, nor did he use it in any way.

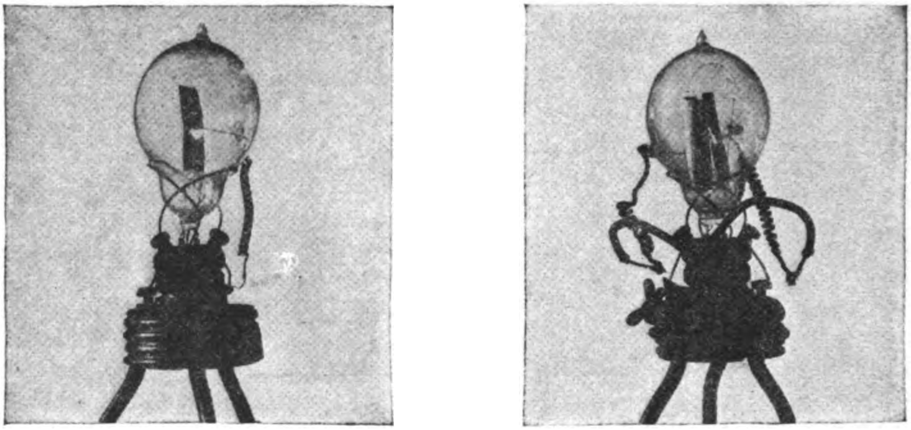
In October, 1884, Sir William Preece obtained from Edison some of these electric lamps with metal plates sealed inside them, and he turned his attention to the investigation of the phenomena of the Edison effect. He decided the Edison effect was connected with the projection of carbon molecules from the filament in straight lines, thus confirming my original discovery. There Sir William Preece let the matter rest, just as Edison had done. He did not satisfactorily explain the phenomenon nor did he seek to apply it in any way. The Edison effect remained just a peculiar property, a mystery of the incandescent lamp.



From a photograph made for POPULAR RADIO by Hoppé, London

HE GAVE THE WORLD THE TWO-ELEMENT TUBE RECTIFIER

While Prof. J. A. Fleming was investigating the phenomena of the disintegration of the filaments in the first Edison electric incandescent lamps he received the first inkling that the filaments in the lamps, while heated, were continuously shooting off particles, which he later found were tiny electric charges. He proved that this was the case by enclosing a plate in with the filament upon which he collected these charges, forming an electric current. Thus was developed the tube rectifier that bears his name.



TWO OF THE EARLY EXPERIMENTS WITH VACUUM TUBES

AT LEFT: *This tube had a filament with a rectangular-shaped plate inserted inside the glass bulb, with leads running through the glass for external connections.*

AT RIGHT: *This tube had a filament and two cylindrical plates, one of which entirely surrounded one leg of the filament. Both of these types of plates are found in modern vacuum tubes.*

Other work claimed my attention for a long time, but I was certain in my own mind that there was still a great deal to discover about this peculiarity of the incandescent lamp, and directly the opportunity occurred I started to investigate the subject once more. In 1888 I had some special lamps made at the Edison and Swan lamp works. Some were strangely shaped, with long glass tubes springing from the sides; others had tubes shaped like the capital "L." The filaments were of carbon, bent round like a horseshoe, and within the bulbs or in the side tubes metal plates were fixed.

With these lamps, I conducted many tests of a highly technical nature, which I fully described in various scientific papers to the Royal Society and Physical Society. I was keenly interested, although the average man would have found little in my laboratory to appeal to him. I fully confirmed Sir William Preece's observations that the molecules discharged from the incandescent filament could not pass round a right-angle bend, and doubly confirmed my original discovery that the molecules traveled in straight lines.

Then I enclosed the negative leg of the carbon filament in a glass tube, and found that the bombardment of electrified particles was completely stopped. By altering the position of the metal plates, I learned that I could vary the intensity of the bombardment. At last I tried placing a metal cylinder completely around the negative leg of the filament without touching it, and the mirror galvanometer that I was using to detect the currents indicated the strongest current of all. It was plain that the metal cylinder enclosing the negative filament caught all the electrified particles that were shot out from the filament.

What I discovered led me to experiment with electric arcs in the open air, and I found that the same phenomenon existed. I published the result of these experiments in a paper in 1889, "On Electrical Discharge Between Electrodes at Different Temperatures in Air and High Vacua."

Thereafter, whenever the opportunity occurred, I continued my experiments with a view to further discoveries. I need not enter into technical details here, but all my researches indicated that the molecules of my original discovery were composed of particles charged with negative electricity. Since the brilliant discoveries of Sir J. J. Thomson in 1897 we have called them "electrons." By surrounding the negative filament with a metal cylinder and bringing the filament to a high state of incandescence, a current of negative electricity was induced to flow from the filament to the plate, but it could not be induced to flow in the opposite direction from the plate to the filament.

I have often been asked to explain why the current could flow one way and not the other, and I think a rough analogy is to liken the glowing filament to a battery of guns always firing shells at a certain target. The shells must travel away from the guns. The impulse is behind them, so they must go forward. It is physically impossible for them to travel toward the guns from which they have been fired. In hitting the target the shells burst and expend their energy, just as the electrons give up their energy, or negative electricity, when they hit the cylinder surrounding the filament.

It is thus easy to understand why the current can flow only one way, that is, from the filament to the cylinder. The electrons are like porters, all hurrying in one direction with a tiny load of negative electricity. As there are no porters traveling in the opposite direction, it is impossible to get any current carried back again.

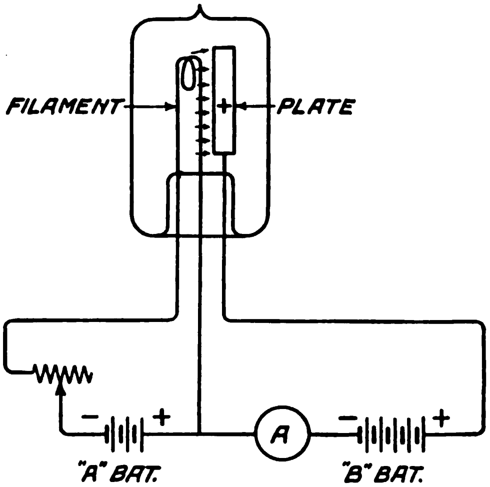
In 1899 I was asked to act as electrical adviser to Marconi's Wireless Telegraph Company and to assist in solving the technical problem of equipping the first transatlantic wireless station at Poldhu with electrical apparatus that would send a wireless impulse across the Atlantic. At that time a wireless signal had not been sent much over 100 miles, so it was a big jump to send a signal 2,000 miles.

We realized that high power would be necessary, and that the old methods of supplying power would be useless. Accordingly, we ordered certain machinery, which was installed in due course, and in November, 1901, Senatore Marconi, with two assistants, went to St. John's, Newfoundland, to see if it was possible to obtain messages from Poldhu.

The weather was bad. High winds enveloped them as they stood on Signal Hill trying to induce their kites and balloons to rise in the air. They had barely coaxed one kite to rise when it broke from its moorings and fell into the sea. They tried again until at last the long-looked-for signal was detected. On December 12 they heard three distinct taps signaling the letter "S" and wireless telegraphy across the Atlantic was an accomplished fact, needing only more perfect instruments to make it commercially possible.

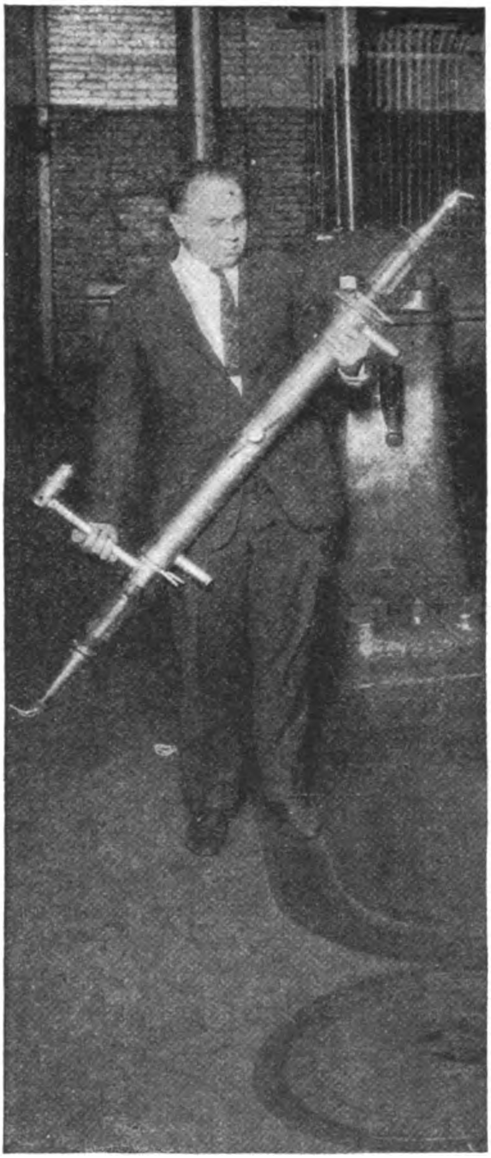
In those early days the coherer was used to detect signals. All wireless students know how it works. The metal filings in the coherer leap together at the touch of an electrical impulse and form a bridge for the current to pass over, and they have to be tapped apart before they can detect another electrical impulse. Senatore Marconi improved on the coherer as a receiver by inventing the magnetic detector. Yet there was room for still further improvement.

Wireless waves from spark sets arrive as a series of impulses, or gushes, and they set up an alternating current in the aerial wire,



HOW THE FLEMING VALVE WORKS

This diagram illustrates the passage of the electrons from the filament to the plate, thus causing a current to flow through the meter deflecting its needle.



General Electric

THE GIANT OFFSPRING OF THE MIDGET FLEMING VALVE

Like the model shown on page 175, this latest product of the electrical laboratory is a two-element vacuum tube. It handles 1,000 kilowatts of oscillating electrical energy, or more than 1,000,000 times as much as its tiny forebear. This great tube, however, uses a filament current of thousands of amperes, whereas its forerunner used less than one. It is possible that some time in the near future similar vacuum tubes will be used for extremely high power purposes, for converting high potential D.C. to A.C. and vice versa.

that is, a current that swings backward and forward. I realized that if this alternating current could be rectified or converted into direct current, it would be possible to use the mirror galvanometer of Kelvin to register oscillations that were possibly too weak for the known receivers to detect. I aimed, like many other men, to stop the current swinging back and to make it always flow forward.

It was a difficult problem. I experimented with many of the rectifiers then in use in my efforts to solve it. One rectifier can be made of plates of aluminum and graphite immersed in a solution of certain salts. The current was able to pass freely from the graphite to the aluminum, but when the current was reversed and attempts made to make it flow from the aluminum to the graphite, a deposit formed on the aluminum, which effectually stopped the current from flowing.

While this acted well enough for certain purposes when the frequency of the currents was low, it was quite useless for wireless purposes. With a low frequency current the electric impulses, coming slowly, gave time for the deposits to form on the aluminum plates. But wireless oscillations, coming at the rate of hundreds of thousands or millions a second, were so rapid that they gave no time to create the deposits.

Finding that these chemical rectifiers were not suitable for use with high frequency currents, I sought something that would operate more rapidly as a rectifier. I was pondering on the difficulties of the problem when my thoughts recurred to my experiments in connection with the Edison effect.

"Why not try the lamps?" I thought.

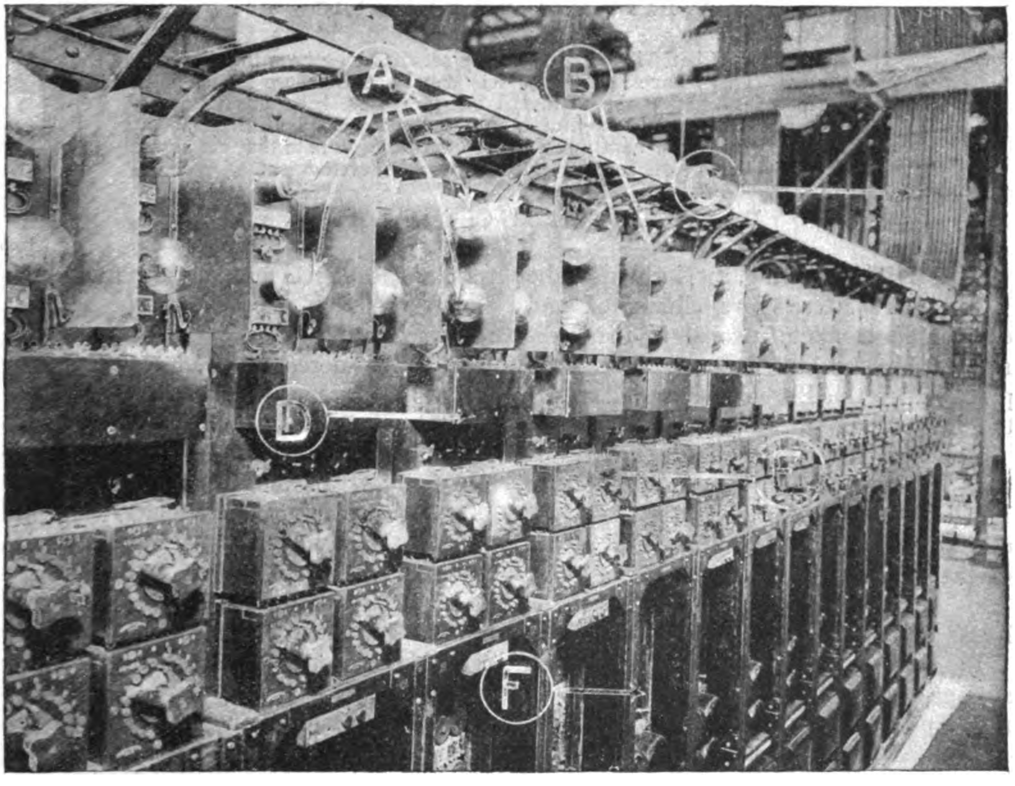
Then and there I determined to see if they would serve the purpose. I went to a cabinet and brought out the same lamps that I had used in my previous investigations. My assistant helped me to construct an oscillatory circuit with two Leyden jars, a wired wooden frame, and an induction coil. We then made another circuit, in which was inserted one of the lamps and a galvanometer, afterward tuning it to the same frequency as the first circuit.

It was about 5 o'clock in the evening when the apparatus was completed. I was, of course, most anxious to try the experiment without further loss of time. We set the two circuits some distance apart in the laboratory, and I started the oscillations in the primary circuit.

To my delight I saw that the needle of the galvanometer indicated a steady direct current passing through, and found that we had in this peculiar kind of electric lamp a solution of the problem of rectifying high frequency wireless currents. The missing link in wireless was found—and it was an electric lamp.

I saw at once that the metal plate should be replaced by a metal cylinder enclosing the whole filament, so as to collect all the electrons projected from it. I accordingly had many carbon filament lamps made with metal cylinders and used them for rectifying the high frequency currents of wireless telegraphy.

This instrument I named an *oscillation valve.* It was at once found to be of value in wireless telegraphy, the mirror galvanometer that I used being replaced by an ordinary telephone, a replacement that could be made with advantage in those days when the spark system of wireless telegraphy was employed. In this form my valve was somewhat extensively used by Marconi's Telegraph Company as a detector of wireless waves. I applied for a patent in Great Britain on November 16, 1904.



A RELAY STATION WHERE TELEPHONE SIGNALS ARE AMPLIFIED

Without these vacuum tubes, A, long-distance telephony would be impossible. B shows the metal shields that prevent interference; C the incoming telephone lines; D the grid batteries; E the amplification controls and F the filter circuits.

In 1907 De Forest added the grid, consisting of a zigzag wire placed between the filament and the plate. Thus was born into the world the valuable thermionic valve, consisting of an incandescent filament enclosed in a highly exhausted glass bulb, the filament being surrounded by a metal cylinder, with a wire grid or cylinder of metal gauze placed between the cylinder and the filament.

It may be truly said that a little thing like a burned-out lamp led up in the course of years, and after countless experiments by many scientists, to the modern miracle of wireless telephony.

Since the date of my experiments in 1904 a countless multitude of eminent scientists have turned their attention to the study of the thermionic valve. In its three-electrode form, that is, with the spiral wire grid in addition to my metal cylinder, it has given us the solution of a long-considered problem—that of making a perfect telephone relay. It has enabled us to transmit speech by ordinary wires thousands of miles overland, as well as making possible the achievement of wireless telephony. It has become the master weapon of the telephonic engineer.

We are even now not nearly at the end of the services it may render to electrical science and to mankind.

A Novel Receiver

WITHOUT BATTERIES

The elimination of batteries from receiving sets has long been the subject of experiment. There have been some sets developed that use a step down transformer for lighting the filaments, but they have been unsatisfactory. Here is a set that uses 60-cycle house-lighting current for both the filaments and the plates of the vacuum tubes. It is interesting to note that the crystal detector has been reverted to in this development.

By LAURENCE M COCKADAY, R. E.

A RADIO receiving set in which the usual batteries are eliminated and connection is made instead to the ordinary lamp socket is now considered practical by the Bureau of Standards of the Department of Commerce.

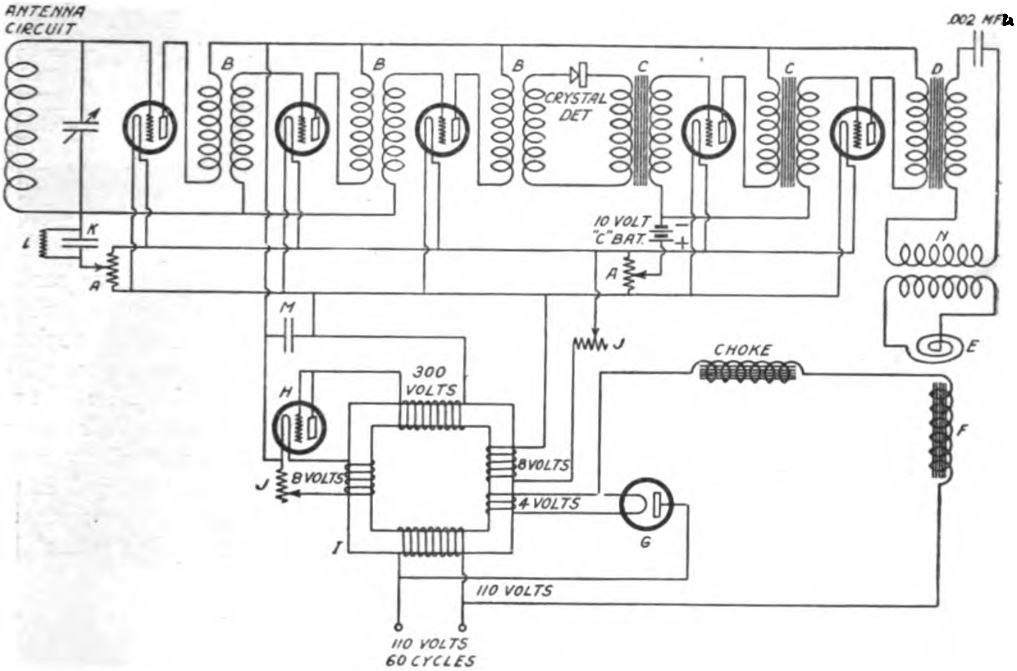
The apparatus is a simple tuner. It may be used with any type of antenna. It eliminates the storage battery which is ordinarily required to light the filaments of the vacuum tubes and which is bulky and heavy and dangerous about the house because of the acid it contains.

In this amplifier both the filament storage battery and the dry battery used in the plate circuit are replaced by a special transformer and an electron-tube rectifier and accessories, the aggregate bulk and weight of which is less than that of the batteries. It uses a small 10-volt dry battery in the grid circuit which is required to deliver only a very small current and should have a life of at least several months.

In order to reduce the hum of the alternating current, there are more adjustments to make than in the ordinary amplifier supplied from batteries.

Of the parts in this amplifier that replace the storage battery in the ordinary amplifier, the special transformer is the only one the cost of which would approach the cost of a storage battery. The cost of the transformer would probably be mainly the labor of assembling it.

This amplifier has three radio frequency stages and two audio frequency stages, and uses a crystal detector. The 60-cycle current when used in an ordinary amplifier circuit introduces a strong 60-cycle note in the telephone



THE•CIRCUIT DIAGRAM FOR THE RECEIVER

The antenna circuit consists of a loop shunted by a variable condenser, and the other parts are designated as follows: A, potentiometers; B, radio frequency amplifying transformers; C, audio frequency amplifying transformers; D, step down transformer; E, moving coil of the loudspeaker; F, field coil of the loudspeaker; G, rectifying vacuum tube; H, vacuum tube used as a high voltage rectifier; I, special 5-winding transformer; J, filament rheostats; K, condenser; L, grid leak; M, large capacity condenser; N, telephone condenser.

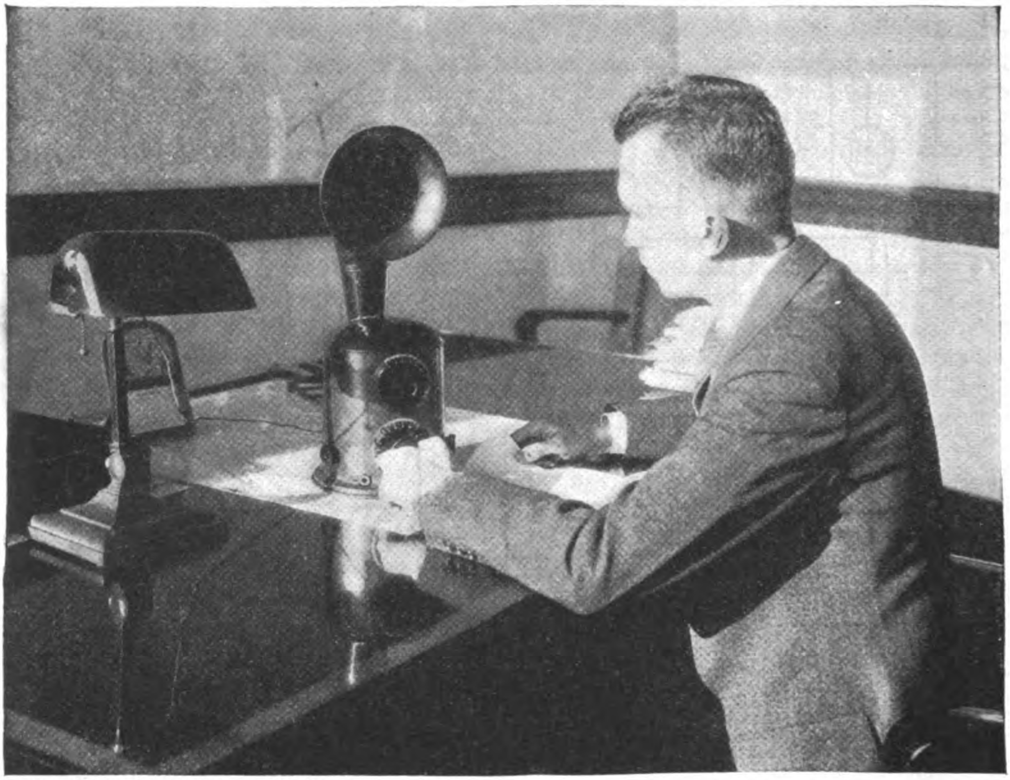
receivers and makes reception impossible. This has been practically eliminated by the balancing resistances, grid condensers and special grid leaks of comparatively low resistance, telephone transformer in the output circuit and use of crystal detector instead of electron tube detector.

In the final form of the amplifier, there is only a slight residual hum. The amplification obtained is as good as that obtained with the same amplifier, using direct current. The complete outfit including the loop is compact and portable.

The amplifier as constructed operates most satisfactorily for wavelengths from 200 to 750 meters. This range was determined by the working range of the radio frequency transformers used. By using suitable radio frequency transformers, this range can be extended to receive any radio waves. The circuit diagram of the outfit, including the means of supplying current to a loudspeaking telephone receiver, is given in the accompanying diagram.

A New Method of Tuning on a Super-Sensitive Receiver

Radio amateurs who have constructed the remarkable long-distance set developed by Laurence M. Cockaday and described in detail in the article "How to Build a Real DX Regenerative Receiver" published in Popular Radio for January, 1923, will be glad to learn that Mr. Cockaday has developed a still more efficient apparatus that will be exclusively announced and described—after the present series of tests are completed—in this magazine.



From a photograph made for POPULAR RADIO

A RECEIVING SET THAT USES ELECTRIC LIGHT WIRES AS AN ANTENNA

Merely by screwing the plug into the socket of an electric lamp you may now listen in on broadcast programs. This apparatus is designed to operate by means of wired wireless—or "line radio," as it is more familiarly known.

WHAT REALLY GUIDES RADIO WAVES?

"The Heaviside Layer" answers Sir Oliver Lodge. "The earth" answers Dr. Elihu Thomson. In this article the Chief Signal Officer of the Army summarizes the controversy and points out the bearing that line radio has upon this live problem

BY MAJOR GENERAL GEORGE O. SQUIER, U. S. A.

IN the recent controversy regarding the Heaviside layer,* no note has been taken of the recent results achieved by "wired wireless," which in my opinion has an important and striking bearing on the interesting question now in discussion.

In "wired wireless" or "line radio" we are dealing with electric wave propagation just as we are in space radio. But surely in "wired wireless" there is no question of a Heaviside layer, since the electric lines of force terminate on the wire conductors when a metallic return

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**See "Is the Heaviside Layer Valid?" by Dr. Elihu Thomson in* POPULAR RADIO *for December, 1922, and "What Bends Radio Waves" by Sir Oliver Lodge in January, 1923, in which each of these scientists explains his conception of the solution of this problem.*

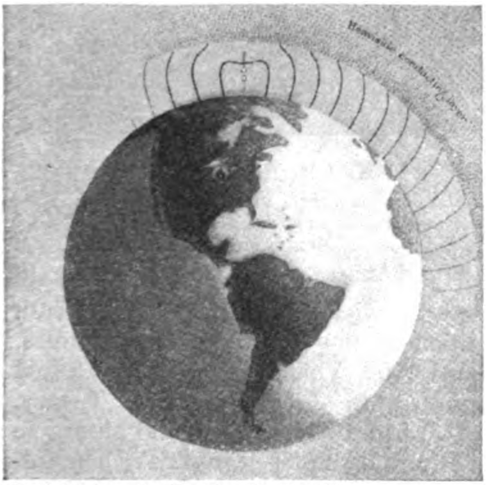
is used, or on the conductor and the earth when an earth return is used. In either case the conductors, or the conductor and ground, serve as the guides for the electric waves by directing them in their travel.

When electrical impulses travel along a wire, they stick close to it, gliding along it or through it and turning corners when it turns. Is it not logical to think of radio waves as using the earth like a wire and gliding over it? The principal difference is that the wire is essentially a line, one dimensional, while the earth can be considered in this case as a surface, two dimensional. The wire guides the impulses directly to their destination with little loss, while the space radio impulses spread over the surface of the earth in the same way that the waves created by the drop of a pebble spread over the surface of a pond.

The way in which the electric waves are propagated in the two kinds of wireless is strikingly similar. In the case of space radio the surface of the earth acts as the guide of the impulses, whereas in "wired wireless," a special kind of earth, in the form of a copper wire, acts as the guide. If the two antennas, used for sending and receiving a space radio message, were connected by a wire, the line radio condition is obtained and the transfer of the impulses between the two points becomes simpler.

That is essentially what was done when I invented wired wireless or line radio in 1910. The radio waves glided along a wire instead of the earth. It was demonstrated that many simultaneous messages could be sent over a wire just as they could be made to glide over the surface of the earth.

When five telephone and twenty telegraphic messages can be successfully carried commercially on one long-distance toll line by using line radio or wired wireless, which is essentially a gliding wave phenomena, what is the necessity of inventing a hypothetical layer, sixty miles or so up in the air, that reflects the waves successively and sends them zigzagly on their way around the earth? It seems to me that the gliding wave



Reprinted from the November POPULAR RADIO

DIAGRAM OF THE HEAVISIDE LAYER THEORY

According to most scientists, radio waves are reflected from and transmitted around the earth by a layer of ionized gas that is suspended about sixty miles high in the atmosphere of the earth. Sir Oliver Lodge is the foremost exponent of this theory.

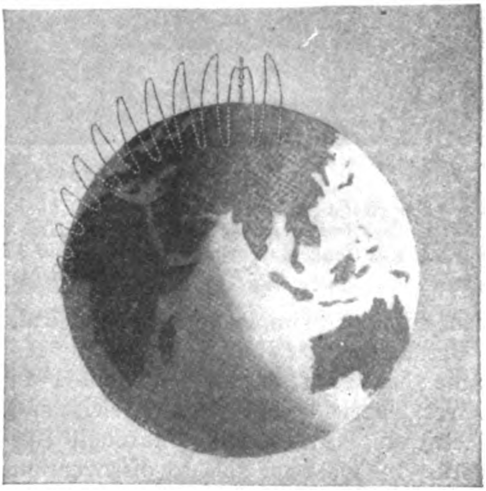
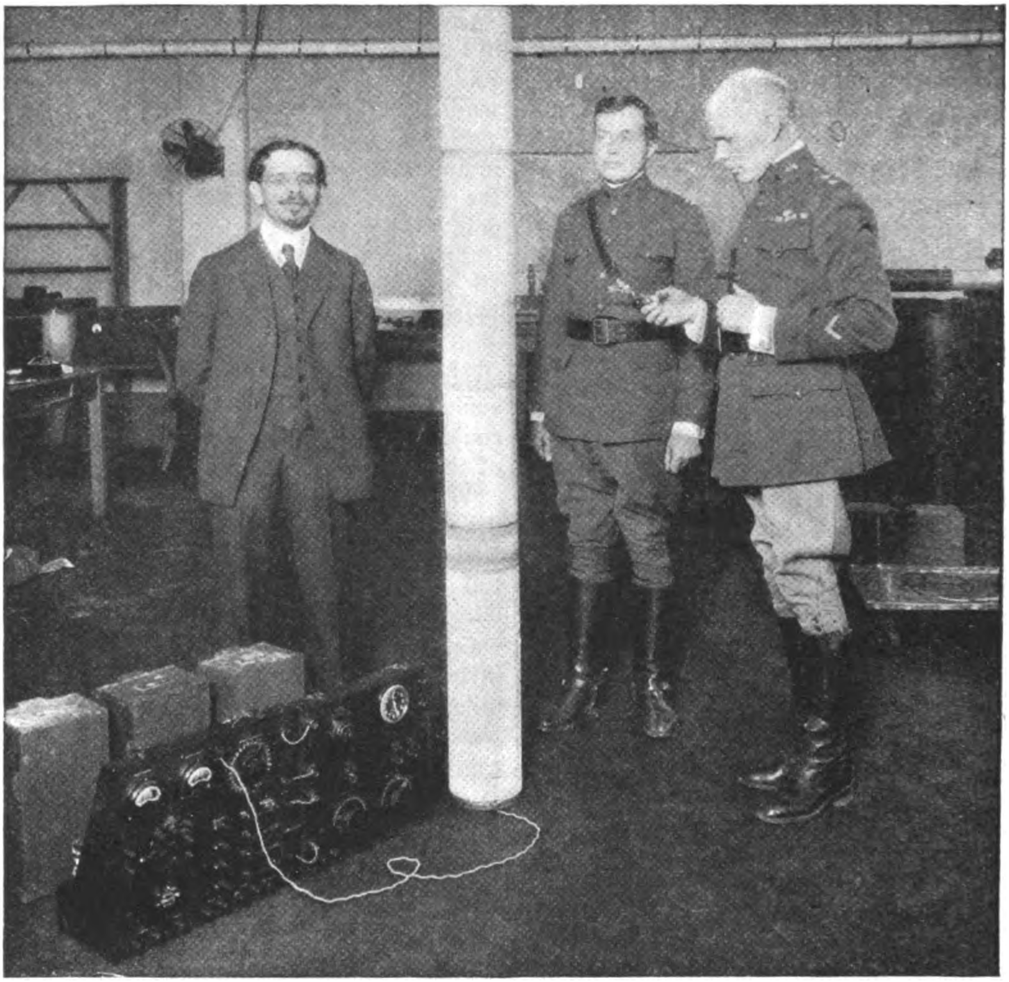


DIAGRAM OF THE GUIDING WAVE THEORY

On the other hand, a number of eminent scientists (of which Dr. Elihu Thomson is one) maintain that radio waves are attached to and glide over the earth, following its contour in much the same way as do the radio waves in line radio.



U. S. Signal Corps

THE "BIG THREE" IN ARMY RADIO CIRCLES

The civilian at the left is Dr. Louis Cohen, the mathematical expert of the U. S. Signal Corps; in the center is Capt. Guy Hill, inventor and radio expert. At the right is Major General George O. Squier, Chief Signal Officer of the Army and the discoverer and foremost exponent of line radio.

theory is much simpler and more logical.

But I fear that the theory bearing his name has been unjustly attributed to Oliver Heaviside, the great physicist and electrician. In looking through his works, I have been able to discover but one suggestion of an upper layer and this is probably the basis for giving his name to the idea. But I do find that he explains wired wireless with uncanny clearness and that he holds strongly to the gliding theory of radio transmission that wired wireless so clearly proves. Let me quote Heaviside himself. In the Tenth Edition of the Encyclopedia Britannica, issued 1902, Vol. 33, pages 214-215 and reprinted in Electromagnetic Theory, Vol. 3, pages 334-335, we find an article by Heaviside on "Telegraphy." The following is an excerpt from it:

> Comparing the case of the cylindrical wires with the so-called "wireless" case, though there is little difference in theory, there is great difference in practice. Using wires, we can send radiation anywhere we like in small quantities without loss. One wire and earth is enough, but two parallel

wires are preferable, to avoid certain interferences. Were it not for the resistance of the wires, and a litle disturbance and loss in turning corners (for the wires need not be straight), telegraphy with wires would be perfect, by any path to any distance. But in "wireless telegraphy," though no expensive connecting wires are required, which gives a remarkable freedom in certain ways, there is enormous loss, and enormous power is required to send workable signals across the Atlantic, since they are being sent simultaneously everywhere. But for this loss by expansion and by resistance, and possible unsettled interferences, there is no reason to limit the distance. The course of a wave round the earth can be easily followed graphically.

When a wave sent along wires comes to a sharp bend in the circuit, a new wave is generated at the bend. This, combined with the old wave, forms the wave after passing the bend. There is a rapid accommodation of the wave round the wire to the new direction. But if the bending is continuous, instead of abrupt, the accommodation goes on continuously also. The reason is that the electrification cannot leave the wires, so the wave in close proximity must accommodate itself to them. A part of the wave, however, really does go off into space with some loss of energy at a sharp corner by its own natural tendency to keep going, but the wire serves to guide the disturbance round the corner as a whole, by holding on to the tubes of displacement by their ends. This guidance is obviously a most important property of wires.

There is something similar in "wireless" telegraphy. Sea water, though transparent to light, has quite enough conductivity to make it behave as a conductor for Hertzian waves, and the same is true in a more imperfect manner of the earth. Hence the waves accommodate themselves to the surface of the sea in the same way as waves follow wires. The irregularities make confusion, no doubt, but the main waves are pulled round by the curvature of the earth, and do not jump off. There is another consideration. There may possibly be a sufficiently conducting layer in the upper air. If so, the waves will, so to speak, catch on to it more or less. Then the guidance will be by the sea on one side and the upper layer on the other. But obstructions, on land especially, may not be conducting enough to make waves go round them fairly. The waves will go partly through them."

You will note that even the suggestive afterthought in the last paragraph does not involve the idea of reflection of the waves that is included in recent discussions of the so-called Heaviside layer. It is merely the idea of the earth being one conducting medium and the upper layer being another.

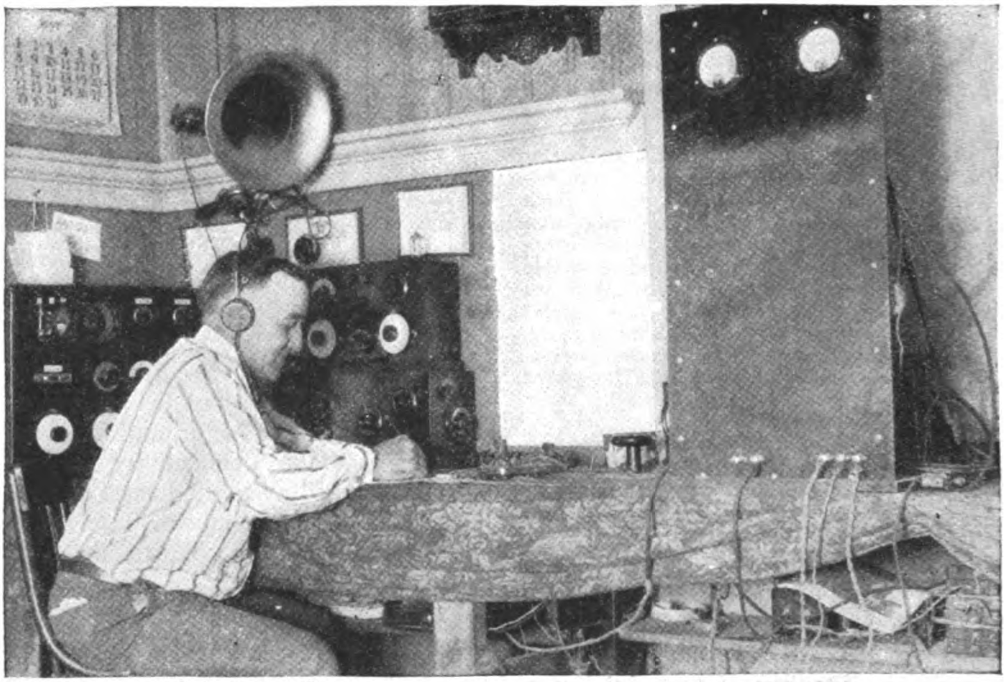
The influence of daylight on radio transmission, which has been one of the main arguments in support of the Heaviside layer theory, it seems to me, is just what one would expect on the gliding wave theory. On the gliding wave theory the conductivity of the surface of the earth is a prime factor, and it is conceivable that this conductivity is profoundly affected by the influence of sunlight, so that this argument, it seems to me, is equally applicable to the two theories.

I may add here that it is believed that many of the outstanding difficulties which are met with in space radio will become more and more understood as we further investigate "line radio."

Radio will advance through the door of wired wireless. Radio over wires is simply a special kind of radio, but it is becoming the laboratory method through which ideas are tried out before they are allowed to clutter up space.

Wireless, guided by wires, immediately and completely eliminates the discouragements of the radio enthusiast—fading, day effects and static. It reduces radio to the reliability of the best D. C. wire circuit. Experiments may thus be conducted day and night, under ideal conditions, without bothering anyone else. I confidently expect that the future advances in radio will be first worked out on wires and not in space. Already radio has benefited greatly by the filters which were originally developed for line radio telephone work. The logical order of progress is from the simpler "conducting wires" to the more complex radiating systems of space radio.

¶ *A new series of articles by one of the foremost authorities on radio phenomena,* Prof. J. H. Morecroft, *of Columbia University, will start in the next number of* Popular Radio.



From a photograph made for POPULAR RADIO

A TYPICAL AMATEUR OF THE INNER CIRCLE
KNOWN AS "THE GANG"

The fact that H. L. Gooding, owner and operator of station 6ZZ, happens to live out in Douglas, Arizona, does not mean that he is isolated. For he belongs to that group of about 300 amateurs who communicate with each other nightly from coast to coast as casually as some of us converse with friends at our clubs.

The Radio Amateur

As I Have Found Him

His peculiarities of temperament, method and character as understood (and shared) by the one man in the world who has the most intimate knowledge of him—

HIRAM PERCY MAXIM

IN the year 1906, there lived in a little town in the Mississippi Valley a certain lad, who was at that time twelve years of age. Had you known him, you would have noticed nothing that marked him from other boys. Possibly he may have been a shade more thoughtful, or more interested in scientific things.

One day his eye fell upon an item in the newspaper which he delivered every afternoon. The item described the latest effort of Guglielmo Marconi in wireless telegraphy. This lad was tremendously interested. He read the article again, more slowly. It gave him the most intense pleasure and thrill to imagine all the things that lay between the lines. He read it again, and then again, and it caused him to be late upon his route, the first time in his life.

When he reached his home that afternoon he had searched out a copy of the paper which he could keep for himself. He cut out the item about Marconi and his wireless, and after giving it a final reading he carefully secreted it with certain other precious belongings.

At frequent intervals thereafter this item was brought forth and carefully reread. It became very dirty and frazzled, and small parts were missing. But they made no difference, for he knew it all by heart.

A great hunger grew within him to know more about wireless. He asked his father about Marconi and wireless telegraphy. The tired and hard-worked parent knew only the bare fact that a man named Marconi was working upon something which was called "wireless." The lad was disappointed. He had hoped that his father might have at least one new fact to give him to think and marvel over.

The lad asked his school teacher. He knew the postmaster, so he asked him. He asked his friend the policeman, and a locomotive engineer who lived next door; and scraped an acquaintance with the telegraph operator at the railroad station. It was all so disappointing. The sole bit of additional information was that "wireless was electrical."

One afternoon, before starting out with his papers, he screwed up his nerve to the necessary pitch to ask the stern-looking elderly lady in the Public Library. She had never heard of Marconi nor wireless, and viewed him with frank suspicion.

Then a wonderful day came. In an ash barrel he found an old copy of *The Scientific American.* His eyes almost

From a photograph made for POPULAR RADIO

ONE OF THE OLD-TIME "SPARK HOUNDS"

Not only did Carl E. Trube of Yonkers, New York, design his own station 2BK, but he built it himself. He is one of the few expert amateurs who uses the spark transmitter instead of the C. W., and his "stonecrusher" became known throughout the land.

popped out of his head, when, looking through the pages, he found an illustrated article on a recently built Marconi station. He retreated with his prize to a quiet spot, and there he read and reread the article, and all but burned out his strong young eyes trying to pull out of the blurred illustration the obscure detail. The article was finally cut out and carefully put away. Every night for weeks, before he climbed into bed, he brought out the dirty bit of paper and read it over again.

This lad was a real wireless amateur, running true to form.

This boy had no notion, even the most remote, what "wireless telegraphy" was. But he was overwhelmingly impressed by it. He had no idea in the world that he was an amateur in the making. Nor had he the remotest thought that there might be others just like him, thirsting for information on the same subject. That there were hundreds of others, young and old, who regarded wireless from exactly the same slant as he regarded it, never crossed his mind. All he knew was that here was the "biggest darned idea for having fun that ever came down the pike."

The lad I am telling of is truly typical of the amateur. I know hundreds of him. I have seen dozens of him grow up from boyhood.

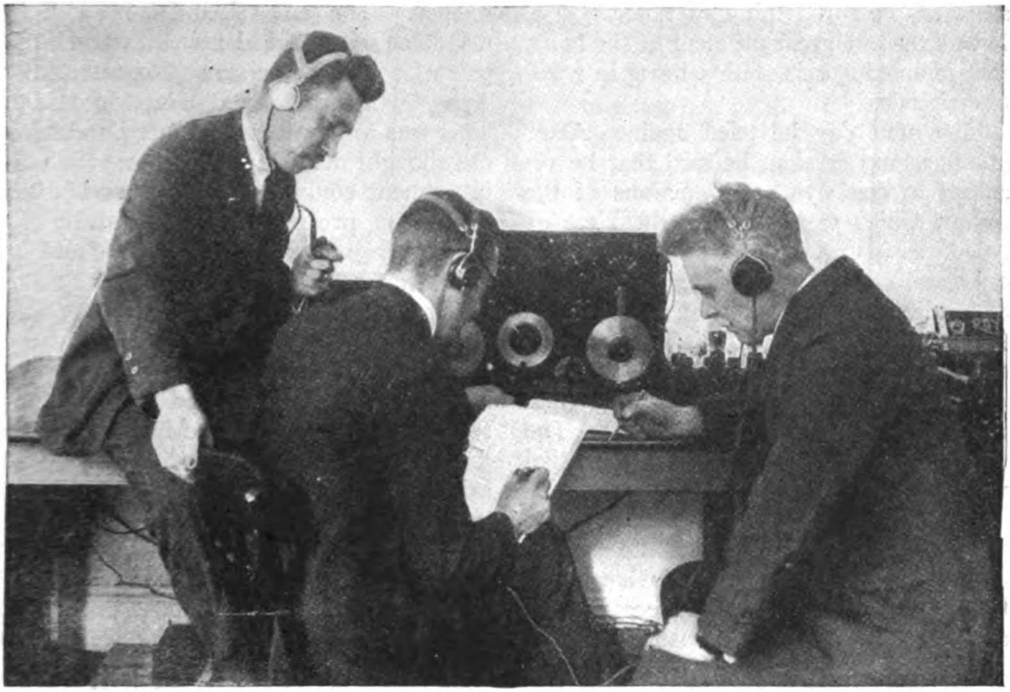
Now for a few words about the general characteristics of this wonderful genus which this lad typifies. He is almost always the son of parents of modest means; almost never is he the son of well-to-do parents. Just why this rule should follow so closely I leave for others to explain. But I can say this: that of all the young fellows whom I have seen take up radio and do something in it, I can recall hardly a single one who has stuck, who has been the son of well-to-do parents. If there is a single one, I hope he will send in his name. I would like to know him.

But let us go back to our story.

Every scrap of information regarding wireless was seized upon and treasured. In the course of events he came to have a fair idea of what a wireless station must look like. But he had never seen one. He dreamed of some day getting hold of enough information to build himself a little amateur station, when he would be able to listen to all the wonderful things that were passing through the air.

Then a great event happened. One day while walking down one of the streets of his little city, what should he see above the top of one of the buildings but an antenna! He could scarcely believe his eyes. A wireless station right here in his own town! There were the wires just as they looked in the pictures. There was, of course, nothing else to do but to trace the lead-in wire down and find where the station was. He could not follow it, but it seemed to enter a saloon. Into the saloon he braved his way. He would have gone through hell-fire and brimstone. The bartender thought he was crazy, as he never had heard of "wireless" and thought the boy was out of his head. The boy saw he was wrong, so he withdrew and searched around behind the saloon. In a tinker's shop he finally located the lead-in wire. It was a place overrun with dust and dirt and old sewing machines, lawn-mowers, and general cast-off household equipment. The proprietor was a well-known character in the town, who was not given credit for being over-bright. The lad asked him if he had a wireless station, and the tinker replied that he had, and pointed to a cleared off space on a bench. Here was mounted a queer assortment of coils and switches, and the telephone receiver from the regular telephone. The tinker person had thought to make use of the regular telephone, and thus save purchasing one especially for the wireless station. A bit of wood held down the hook. When the telephone rang, it was the practice to disconnect the receiver from the wireless station, reconnect it to the regular telephone and answer the call.

The lad glowed as he regarded his first



International

"OLD TIMERS" WHO EMBODY THE SPIRIT OF THE RADIO AMATEUR

No American amateur—and few foreign amateurs, for that matter—needs to be told about Hiram Percy Maxim (at the right), one of the most ardent and most popular of fans and the guiding star of the American Radio Relay League, which is of such inestimable value to the amateur. At his left is Kenneth B. Warner, the secretary of the League, and F. H. Schnell, the traffic manager, who had charge of the recent transatlantic tests.

wireless station. He asked how it worked, and the tinker told him it worked fine, but you couldn't hear anything in it. That seemed strange to the young fellow. Here was a wireless station, yet no wireless messages were coming in on it. He asked questions and it ended by the tinker inviting the boy to try his hand at working the station. In telling me about it, the young fellow said the outfit consisted of a round stick of wood on which had been wound for about a foot, some hundred or so turns of bare copper wire. A slider was arranged to pass over and make contact with these coils and another slider provided the tuning for the telephone circuit. In other words, it was a distinctly home-made, two-slide tuner, such as we used to use in the early days. A bit of galena ore served as a detector; the lump of galena was seated in a wad of tinfoil from a package of chewing tobacco. The antenna consisted of hay-wire, twisted together to make sufficient length to connect between a chimney and a pole fastened to the gable end of the building. The hay-wire was of iron, as is customary with hay-wire.

The lad worked and worked over the little station, while the tinker attended to his daily business. It was vacation time, and so the entire day could be devoted to the job in hand. In telling of it in later years, the boy, now grown up, said that he tried everything that the human brain could think of, but not one single sound could be brought from the outfit. He worked all day long, and when he went home at night it was to study and think and wonder what the trouble might be. Just like every other amateur, he could think of nothing else. It was the one great problem of the hour, that of making this station bring in wireless signals.

The next day he tried again. After another long session, he said that he resolved to disobey the injunctions of the tinker, which were to leave the piece of galena as it was. He resolved to turn it over and try the other side, in the hope of finding a sensitive spot. While the tinker was away he did this. But the results were the same. The galena was reversed again, and placed in its original position before the tinker returned. The second day was unproductive, and the lad went home thoughtful, but not discouraged. He wondered as he lay in his bed what might be the cause of the failure. Mind you, he was wondering what might be the reason for the non-reception of signals, with iron wire twisted together for an antenna and with a two-slide tuner, a piece of totally unknown galena, and a house telephone receiver, possibly of 100 ohms resistance. We now use 3,000 ohm receivers and carefully soldered copper wire antennae, and very sensitive vacuum tubes with amplifiers.

The lad made up his mind that the haywire was not strictly what a wireless station would use, and that it must be the cause of the trouble. In the morning he broached the subject of copper wire, but found that the cost was a serious matter. But a way was found, just as a way is always found, to finance the copper wire. It was put up, and it certainly looked better and as though it might work. Late in the afternoon all was ready and signals were listened for. But there was nothing. The silence of the grave still persisted. The lad again lay awake that night and thought. He then concluded that it was probably not conventional practice in regular wireless stations to use the house telephone as the receiver. It would be probably better to use regular wireless receivers. He broached this to the tinker in the morning, and again the matter of finances obstructed the path of science. The advertisement in a little magazine of electrical novelties told of a pair of wireless receivers, "Regular Navy Type," which could be obtained for $5.00. This was a huge sum of money and serious thought must be taken before such an investment could be entered upon. But again the project was successfully financed by dint of much promising and of far-advanced future commitments. The phones were ordered. It was a terrible ordeal waiting their arrival. Finally the great day came when the parcel post brought them, and the lad told me that seldom in his life has he beheld such a lovely sight as the spectacle of those bright and shining telephone receivers, with their nickel-plated head-band, lying in their little box.

The test with the new phones was made at once, and great excitement prevailed. But sad to relate, the results were precisely what they had been—dead silence.

The next day he returned to the task, with serious thoughts. He had nothing special to try. He simply returned to the job. He turned his galena over for the hundredth time, and behold—the dots and dashes were in the phones! He had never heard any before, but he recognized them at once. There the precious and wonderful things were, tearing along altogether too fast for him to do more than pick out an "O" and an "M" once in a while. He was transfixed. He dared not move for fear they would stop. He listened for a minute or so, and then deciding the tinker must also hear, he roared for him to come. As the older man hurried over to grasp the phones, the signals stopped. (They always do.) An hour was spent in trying to get them again, but to no avail. The tinker doubted if the boy had really heard them. They were gone and could not be brought back.

The boy continued upon his self-appointed task, and he told me that it was days before he again succeeded in getting a sound out of the phones. But the signals were finally brought in, just as every amateur finally brings them in, and it was

From a photograph made for POPULAR RADIO

THE MOST FAMOUS AMATEUR STATION ON THE COAST

Here is the picturesque interior of the radio shack on Catalina Island, which has worked nearly every section of the country. And here, too, is the equally picturesque operator of 6XAD, in private life Lawrence Mott, soldier, game warden, editor and radio fan.

possible nearly always to hear something going on. What he finally did to overcome his trouble, he says he does not know to this day.

Then another great day came. He never had given a thought to the possibility that there might be others just like himself who were trying to get wireless signals. And so when a strange, rasping, scratchy signal, sent so very slowly that even he could read it, came in, the great thought came to him that it might be another amateur, farther advanced than he, who had built himself a transmitting station as well as a receiving station. The thought was staggering. Yet it must be. Who else but an amateur like myself would be stumbling through the code in this manner? And so he came to wonder as to the building of a transmitter.

Finally, and after fully as long and hard an ordeal as with the receiver, he developed a transmitter which from his house, a distance of a half mile, the tinker could distinctly hear at his shop. The tinker had also built himself one, and an exchange of messages began. It was the most thrilling thing he had ever experienced in his life. He was actually possessed of a wireless telegraph station all his own. It was hard to believe that such a day had actually come. He was at the height of his enjoyment over his possession, and the glory that accompanies mastering a big problem, when one night he heard his self-selected call letters faintly, coming from some station other than that of his friend, the tinker. His heart stopped beating. It was the stranger of the air whom he had heard before. And here he was calling him! How had he learned his call letters? He must have heard them as he signed off when working with the tinker. Could it possibly be that his own signals had reached out and were being heard by somebody a long way off? Where could the stranger be?

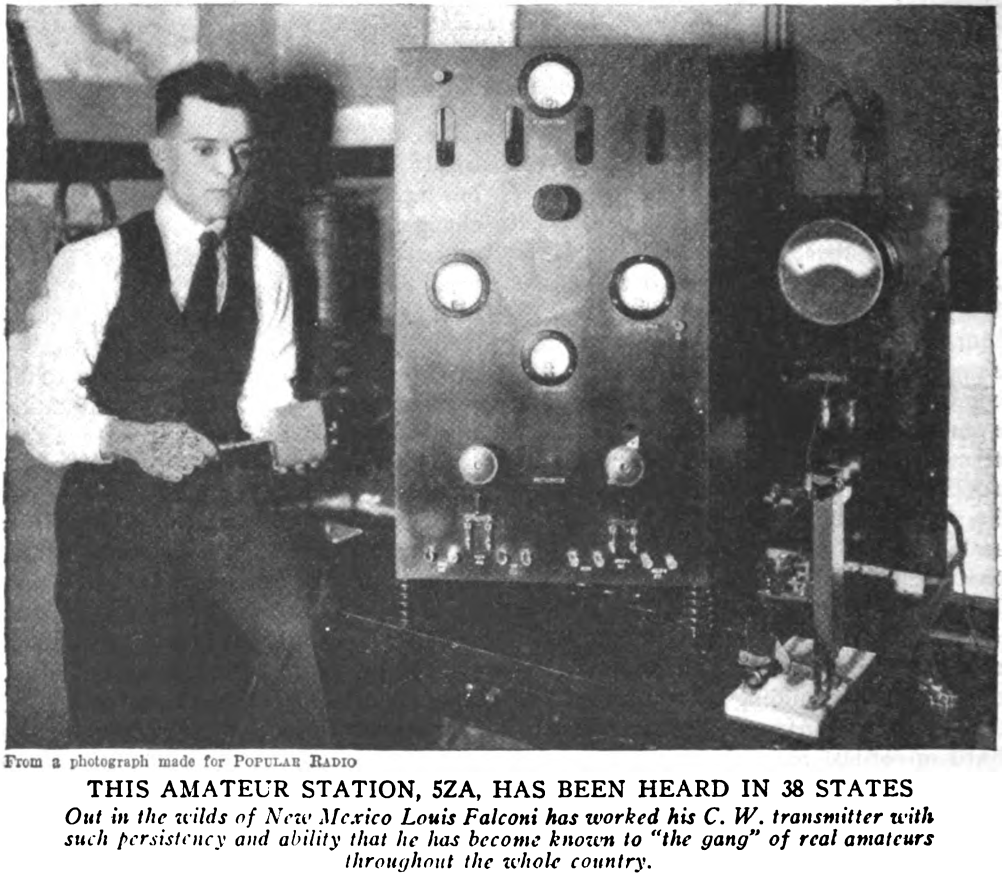
It was breath taking, this hearing his own call coming in faintly, sent by some unknown of the air.

He listened carefully for the stranger's sign-in. He caught it, for it was sent very slowly. He trembled so with excitement when he answered that he could scarcely send. He managed to stumble through the call and the signature, however, and to his profound satisfaction, the stranger came back. He had reached him!

The stranger asked him who and where he was. He told his own name and gave the town where he was located. To the astonishment of my young friend, it was one of the nearby towns, distant some ten miles. The desired information was returned, and each of these young fellows probably enjoyed one of the greatest thrills that will ever come to them in all their lives. They of course looked each other up and a friendship began which will last as long as they live.

My lad grew up and of course took up radio as his life work. He is still an amateur, and if he lives to be eighty he will continue to be one.

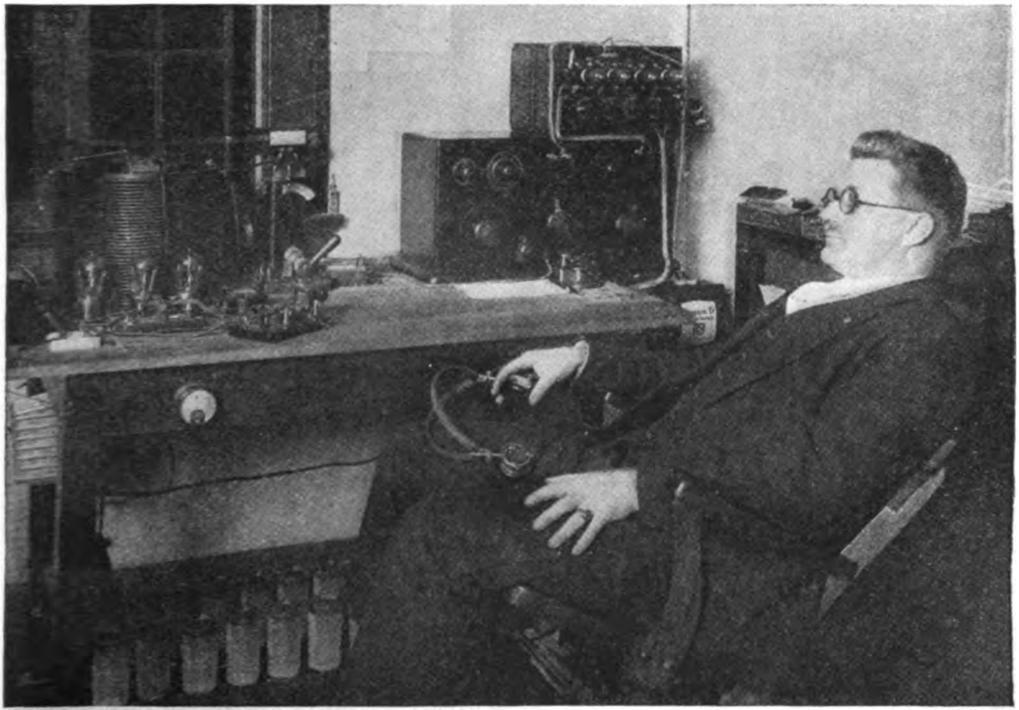
In the latter part of 1913 steps were taken to organize the amateurs all over the country into a relay association. It was named very aptly The American Radio Relay League. The writer was one of those who lent a hand in putting it together. It had become a well developed idea by the end of 1914. In 1915 it was a truly national organization, with representatives from all parts of the country and with a creditable relay system in working order. Messages were



From a photograph made for POPULAR RADIO

THIS AMATEUR STATION, 5ZA, HAS BEEN HEARD IN 38 STATES

Out in the wilds of New Mexico Louis Falconi has worked his C. W. transmitter with such persistency and ability that he has become known to "the gang" of real amateurs throughout the whole country.



From a photograph made for POPULAR RADIO

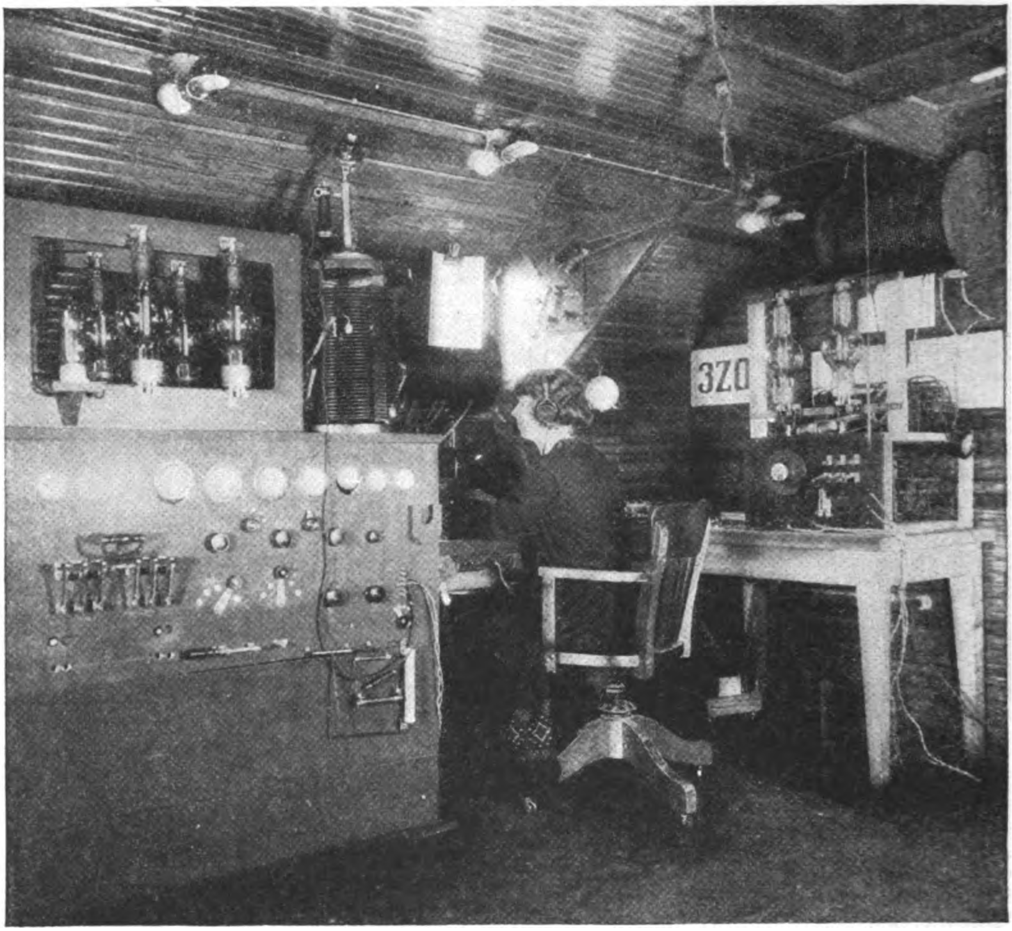
AN AMATEUR WHO BEARS THE TITLE OF "HIGH SPEED KING"

From down in Savannah, Georgia, F. A. Hill (owner and operator of Station 4GL) has been puncturing the ether with the fastest signals ever transmitted by an amateur. He has been known to reel off twenty relay messages without even a pause.

handed on from one station to another, and a fairly large area of the country could be reached. All the snap and vigor of youth was put into the thing, and prodigious effort was made to secure co-operation, better equipment and good operating. By 1916 these young men had become so welded together in a bond of fellowship that they began the publication of their own magazine. They named it *QST*, the international abbreviation for "Attention—All Stations."

In the year 1917 we became involved in the World War. Straightway there came an absolute necessity for hundreds of radio operators. Not only was there a terrible shortage of trained men, but the machinery for training more had not been developed. So one morning the telephone rang in the writer's office, and when it was answered there was a voice which asked if the president of the American Radio Relay League would take the next train for New York and attend an important meeting in connection with radio communication matters. The writer promised. Within the hour he was on his way. Arrived in New York, I found that officers of the Navy desired the assistance of the amateurs. Experienced radio operators must be procured immediately; would the amateurs enlist?

It was a terribly serious situation that faced our country. Operators were required at once, and it would require months to train green men. I gave my word that I would use all the influence I possessed to induce our membership to enlist with the least possible delay. I believed I knew the amateurs, and I did not think they would be found wanting when they realized that their Uncle Sam needed them. I was right. In a few days the League's magazine was sent out with a patriotic appeal to every amateur who



ONE OF THE MOST POWERFUL AMATEUR STATIONS IN SERVICE

Radio fans of the east know station 3ZO and 3XW of Chester, Pennsylvania, owned by the famous Chester Radio Association. Some conception of its equipment may be obtained from this view of its shack. (The woman OP is Miss Bertha Hilton, one of the expert amateurs.) The antenna of this station is shown on page 208 of this issue.

could handle a radio set and who was in good health, to communicate with the nearest recruiting office at once. There was no hesitation. In a few days amateurs began presenting themselves, and in a short time there gathered together hundreds of the best radio men the world ever saw. They were placed in the best positions, in all sorts of ranks from Lieutenant-Commander to enlisted man.

They saved the day for Uncle Sam.

After the war they rebuilt their American Radio Relay League, and put into it the executive and administrative lessons they had learned in the military service. It soon became a greater organization than before. The country was quickly covered with a network of relay lines, and a message traffic many times larger than had been dreamed of began. The handling of these amateur messages was done in the most approved manner. Examples of the most perfect operating that had ever been known could be heard every night in the 200-meter waveband.

Then it became desirable to demonstrate just how efficiently messages could be relayed across the continent, from the Atlantic to the Pacific. Messages were taken in Portland, Maine, addressed to

Portland, Oregon, and from Hartford to Los Angeles, and from New York to New Orleans, and from Chicago to Galveston. The amateurs of the country were asked to be quiet on the nights selected, but to listen in and lend a hand should any of them be required. One of the most thrilling experiences of my own life was listening to the flight of these messages across the continent and hearing them reappear over the western radio horizon as the answers sped back. Repeatedly were messages from my own station in Hartford exchanged with San Francisco and Los Angeles. The quickest was one to the latter city. From the instant the key started the first signal of the message to the time the answer was back and all written out on a telegraph blank was just six and one-half minutes. And this included the time the Los Angeles amateur took to compose his answer, and the Chicago and the Roswell (New Mexico) stations to relay it out and back.

That night the air was as quiet as if no radio stations existed except for those engaged in handling the messages. The organization of the tests and the cooperation of the amateurs of the country was 100 per cent. perfect. At the completion of the tests, when the necessity for quiet no longer existed, it was as though a great swarm of bees had been liberated.

When another year rolled around it was decided to try yet a greater test. An attempt was made to include European countries in the amateur world. Nothing less than transatlantic radio was undertaken. In order to make as certain of the reception on the other side as possible, the most expert reception specialist was selected, and sent to England with what apparatus he believed would be most certain to bring in amateur signals from America. Mr. Paul F. Godley was the amateur selected. After some experimenting he established himself in a field in the little town of Ardrossan, Scotland. When the eventful night for the tests came, the most abominable weather set in, and Mr. Godley and his British checker were obliged to sit all the night through in a wet and cold tent, with the wind howling and everything soaking wet. But he was an American amateur, and notwithstanding the most intense discomfort and actual suffering he actually copied and the checker checked the reception of no less than twenty-six American amateur stations. Some sent actual messages, which were received correctly and completely.

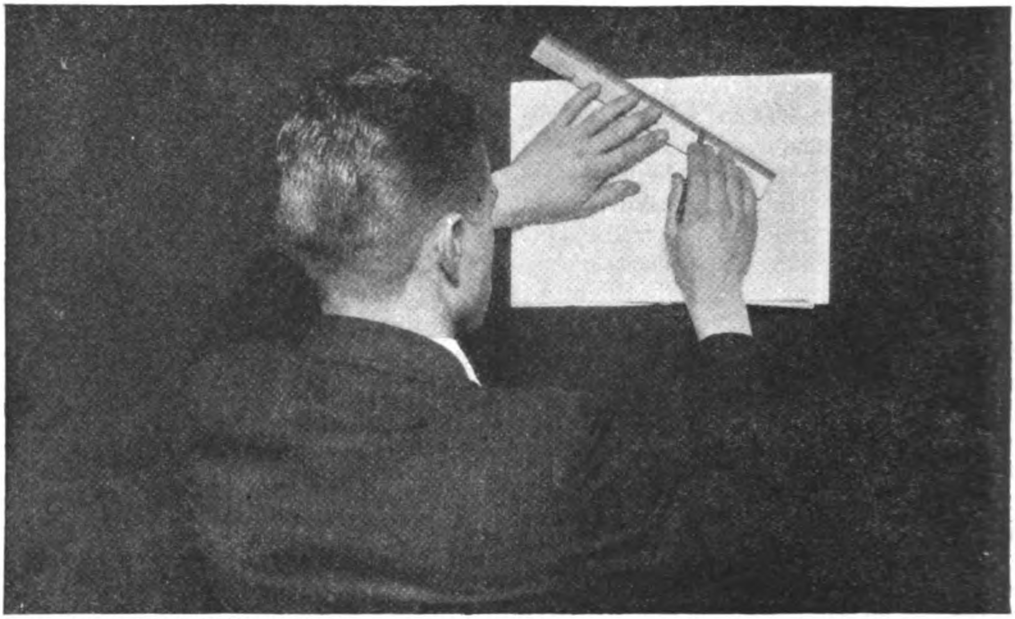
It awakened the British amateurs, as well as the French and the Dutch. The effect was to open transatlantic amateur communication, for English amateurs quickly equipped themselves to receive their American cousins, and the French Government liberated their own amateurs and gave them permission to transmit—a thing which was absolutely prohibited up to this time.

At the present time amateur traffic is moving one way across the Atlantic. Bunches of six messages are transmitted at a time, and the English or French stations receipt for them by cable. It is only a short time before the Europeans will be able to work back to America, and then regular citizen message traffic will move across the Atlantic as it moves across the American continent.

Certainly will this be a far cry from the days when our typical young amateur in the obscure little Mississippi Valley town was struggling to receive signals with a house telephone and some hay-wire on the roof!

How the Transatlantic Tests Were Conducted

The inside story—told by F. H. Schnell, the able traffic manager of the American Radio Relay League—of how 316 Yankee amateurs transmitted signals to Europe will be told in a coming issue of POPULAR RADIO.



From a photograph made for POPULAR RADIO

¶ *Lay your ruler across the alignment chart, as described in this article—and read off at a glance the answer to your problems in calculations.*

MEASUREMENT CHARTS

FOR DETERMINING THE DIMENSIONS OF YOUR COIL

ARTICLE NO. 2

The inventor of the famous "radio slide rule" is the author of this series of short articles and the originator of the accompanying charts, which are designed not only to save a vast amount of time in the calculations incident to the design of radio apparatus, but also to insure absolute accuracy. These charts appear exclusively in POPULAR RADIO.

By RAOUL J. HOFFMAN, A.M.E.

WHEN the amateur has finally decided what range of wavelengths he desires to cover in his proposed transmitting or receiving set, and when he has determined the correct electrical constants for the coils which will cover this range (by means of the alignment charts given in the first article of this series, published in the February, 1923, number), the next step is to construct the coils that will have these constants.

In other words, if the amateur wants to tune to a wavelength of 400 meters and he has an antenna with a capacity of approximately .0002 mfd., his primary coil should have an inductance of 225 microhenries. The question now is:

"What size of coil will I make that will give me this value of inductance?"

Of course the answer can be figured out mathematically by an engineer, but the average radio fan would find himself in water too deep for him if he should try to do it himself.

However, the simple alignment charts that accompany this article have been prepared so that even the novice will find the answer to his problem in a few seconds. These charts are based on mathematical formulas, but all the reader must know is how to draw a straight line and how to read figures.

For the benefit of the more experienced amateur who understands something of mathematics, I will show how the alignment charts for inductance and design of a coil were evolved. The reader may skip the following formulas if he desires and take my word for it that they will answer his problem, in the form of charts, whether he reads and understands them or not.

The formula for inductance of a coil follows the equation:

$$L=4\,\pi^2\left(\frac{d}{2}\right)^2 n^2\, l\, K \ldots\ldots 1$$

wherein

$L =$ the inductance required.
$d =$ the diameter of the coil in centimeters.
$l =$ the length of the coil in centimeters.
$n =$ the number of turns per centimeter.
and $k =$ a constant depending on the ratio d/l.

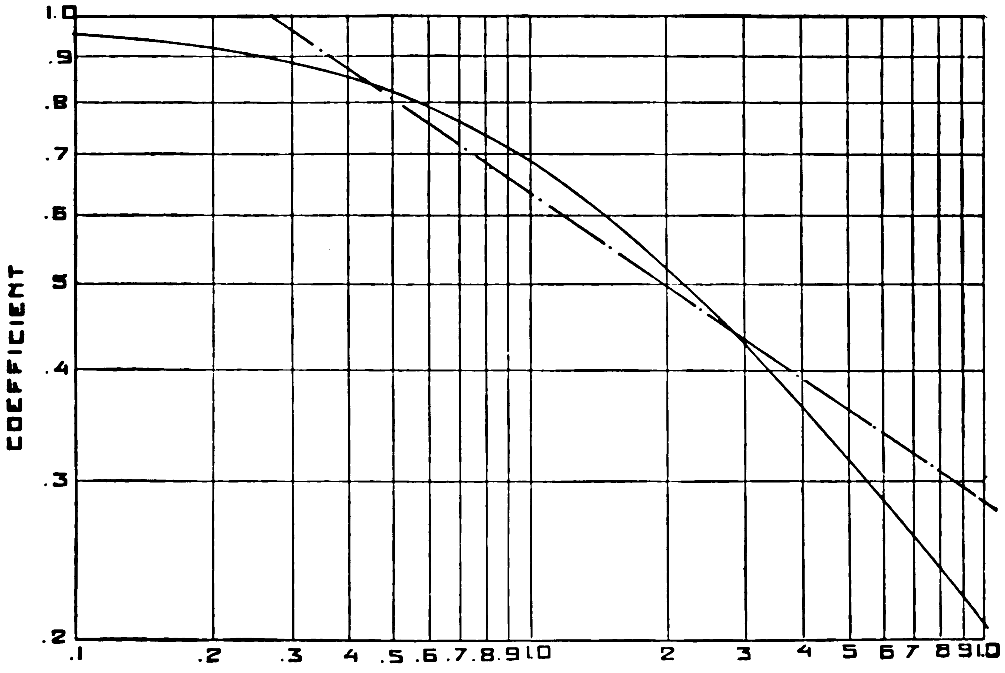
As the correction factor k depends on the relation of the diameter and the length of the coil, we cannot, by means of the above formula, calculate directly the dimensions of a coil assuming the other three variables.

Therefore, in order to make the equation No. 1 available for a simple alignment chart, we will have to eliminate the coefficient k. We plot the correction factor against the ratio d/l on a sheet of logarithmic cross-section paper and substitute a straight line for the curve. By so doing we eliminate this troublesome feature of the formula, with results which will not differ perceptibly from the original values, within the practical limits of a coil design. (See Figure 1.)

The equation for a straight line on logarithmic paper has the form:

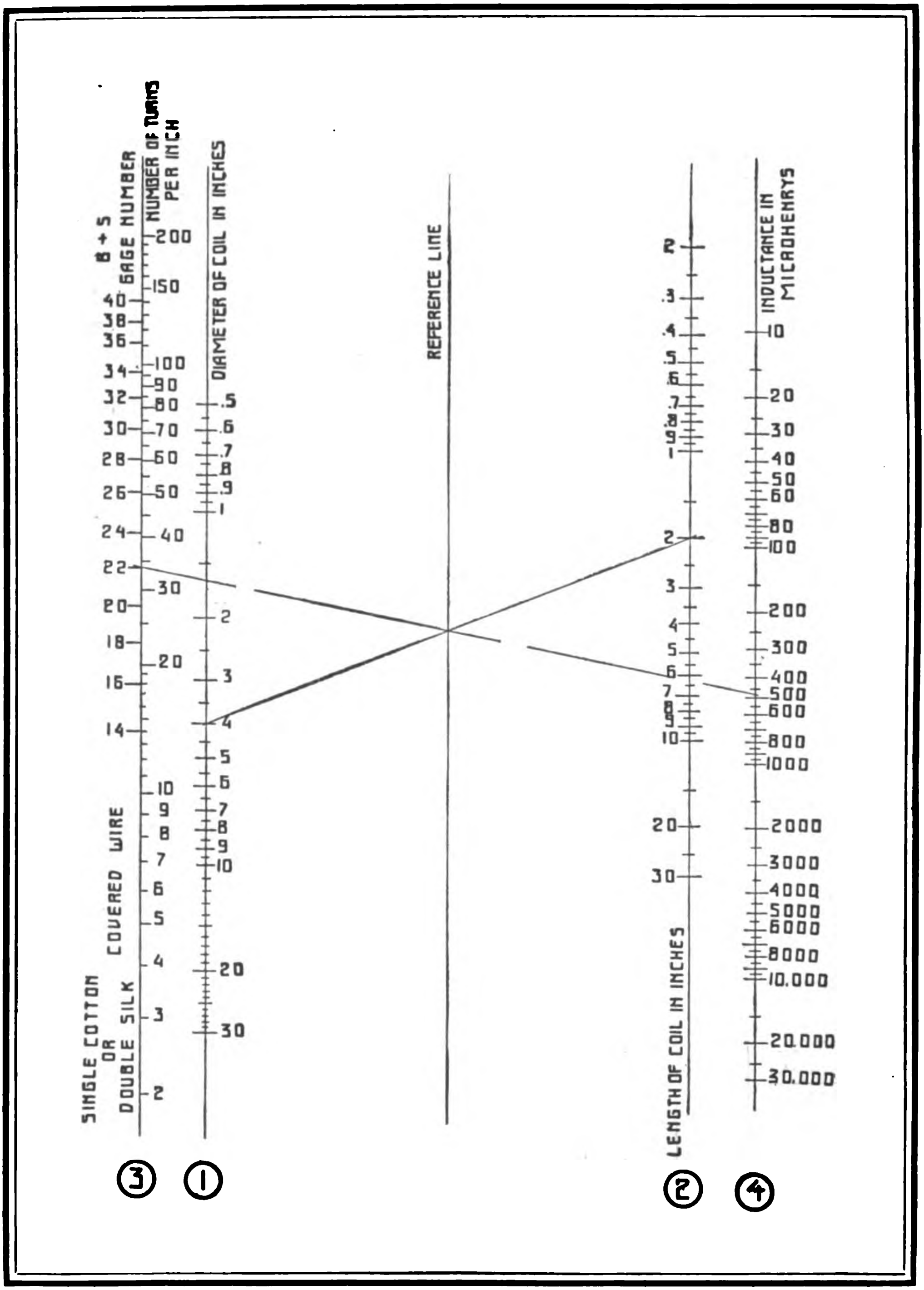
$$y = cx^n \ldots\ldots\ldots\ldots 2$$

where y and x are variables and c and n are constants.



A STEP IN THE PREPARATION OF THE CHART

FIGURE 1—*In this diagram we have the correction factor k, plotted against the ratio d/l, which is shown in the form of a curve. In order to eliminate the factor k from the formula used in the charts, this curve has been replaced by a straight line with results that do not differ perceptibly from the original values in the original curve.*



USE YOUR RULER ON THIS CHART—

as described in the accompanying text—to learn the exact dimensions of the coil you need. Similar charts for determining constants of radio circuits and calculating capacities of condensers in series appeared in POPULAR RADIO *for February, 1923.*

Substituting for y and x the coefficient and the ratio of d/l respectively, the following expression is obtained:

$k = c(l/d)^n$ 3

Evaluating we will have:

$k = c(l/d)^{.35}$ 4

then substituting k (in equation No. 1) by the equation No. 4, we will have:

$L = cn^2 l^{1.35} d^{1.65}$ 5

and using the inductance values found in laboratory tested coils and the units in inches we will have:

$L = .0154 n^2 d^{1.35} l^{1.65}$ 6

where

L = the inductance in microhenries.

n = the number of turns per inch.

d = the diameter of the coil in inches.

and l = the length of the coil in inches.

This formula can be used only with the aid of logarithms. For practical use we have converted it into a chart, shown on the page opposite.

Knowing the inductance value we wish to incorporate in a single layer coil, we must decide two factors in the coil design:

First, the diameter of the tube we intend to wind the coil upon.

Second, the size of wire we intend to wind the coil with.

To understand fully and clearly the use of the chart let us consider the following example:

We want to build a coil with an inductance of 480 microhenries. We have some insulating composition tubing 4 inches in diameter that we want to use. We also have a quantity of No. 22 single-cotton-covered wire on hand that will be suitable.

The problem is: "How much wire will we wind on to make a coil with an inductance of 480 microhenries?"

On the chart on page 200, on scale 3, connect, with a ruler, the size of wire (No. 22) with the inductance in microhenries (480) on scale 4. A line so drawn will cross the reference line at a certain spot. Now turn to scale 1. Connect the diameter of the tube (4 inches) with the before mentioned spot on the reference line and carry the line over until it crosses the scale 2. At this point on scale 2 we find the answer; we need a coil 2 inches long.

We now proceed to wind on the tube (4 inches in diameter) two inches of winding, of No. 22 single-cotton-covered wire—knowing beforehand that the inductance of the completed coil will be 480 microhenries.

Try out these charts the next time you build a receiver or a transmitter and learn for yourself how simple the system is. You will then know exactly what size of coils to use for the wavelength range you want to cover.

In radio work there is no one thing that is more fascinating or more satisfying than the knowledge that you *can* predetermine the "constants" of your set.

From a photograph made for POPULAR RADIO

Regeneration Without Radiation

THIS *timely article by John V. L. Hogan (originally scheduled for publication in this number of* POPULAR RADIO*) will appear in the following issue—April. Mr. Hogan's contribution will be supplemented not only with diagrams but with photographs made in his laboratory from actual models constructed for the express purpose of obtaining illustrations for the text.*

From a photograph made for POPULAR RADIO

THE FIRST MAN TO PICK UP AN AMATEUR'S TRANSATLANTIC SIGNAL

When the author of this article sailed for Scotland in December of 1921 for the purpose of picking up radio signals from American amateurs, his mission was regarded about as foolish as the eventful voyage of Columbus. But he picked up over a score of amateurs—some of whom used less electrical power than is used in an ordinary electric light bulb!

"DEAD SPOTS"

What They Are and How to Find Them

By PAUL GODLEY

ONE of the most important symbols which denote the remarkable progress which has been made by the public toward the absorption of all that is to be known about radio lies in the fact that almost anywhere now, no matter what the nature of the gathering, one is apt to hear some two or more radio fans holding forth earnestly concerning the probability that they reside in a "dead spot."

I find myself wondering each time I come within earshot why someone does not come forward and bravely ask:

"What in the name of Heaven is a dead spot?"

To be frank, I frequently want to ask the question myself, for as far as I have been able to find out, there is no one item connected with radio transmission phenomena which has received as little attention from radio engineers or about which there is as little known as the so called "dead spot."

Many years ago, and but a few weeks after I had for the first time seen a commercial radio outfit, I heard someone in a knowing fashion reel off a lengthy and mystifying yarn which had for its setting a spot in mid-Atlantic where no radio signals had ever been heard from any radio station. But this yarn did not startle me half as much as the one offered immediately in return that had to do with another wonderful spot in mid-Atlantic where signals from stations in all parts of the globe *always* came in with great reliability and distinctness!

Radio folks—professionals and amateurs alike—have long talked about "dead spots." Experience has shown that there *are* certain stretches of coastal territory and mountainous areas where it is extremely difficult to effect reliable communication in the conventional manner. But always the term "dead spot" is a relative one only; a "dead spot" being due to the partial absorption of the electromagnetic waves.

A well-known example of this phenomena lies in the inability of ship stations in Long Island Sound to establish satisfactory communication with shore stations on the Atlantic side of the Island, even though the Island is, at its widest part, but forty miles across. Coastwise vessels find great difficulty in communicating with New York City in a satisfactory fashion over distances of but fifty or sixty miles when they are close to the Jersey shore.

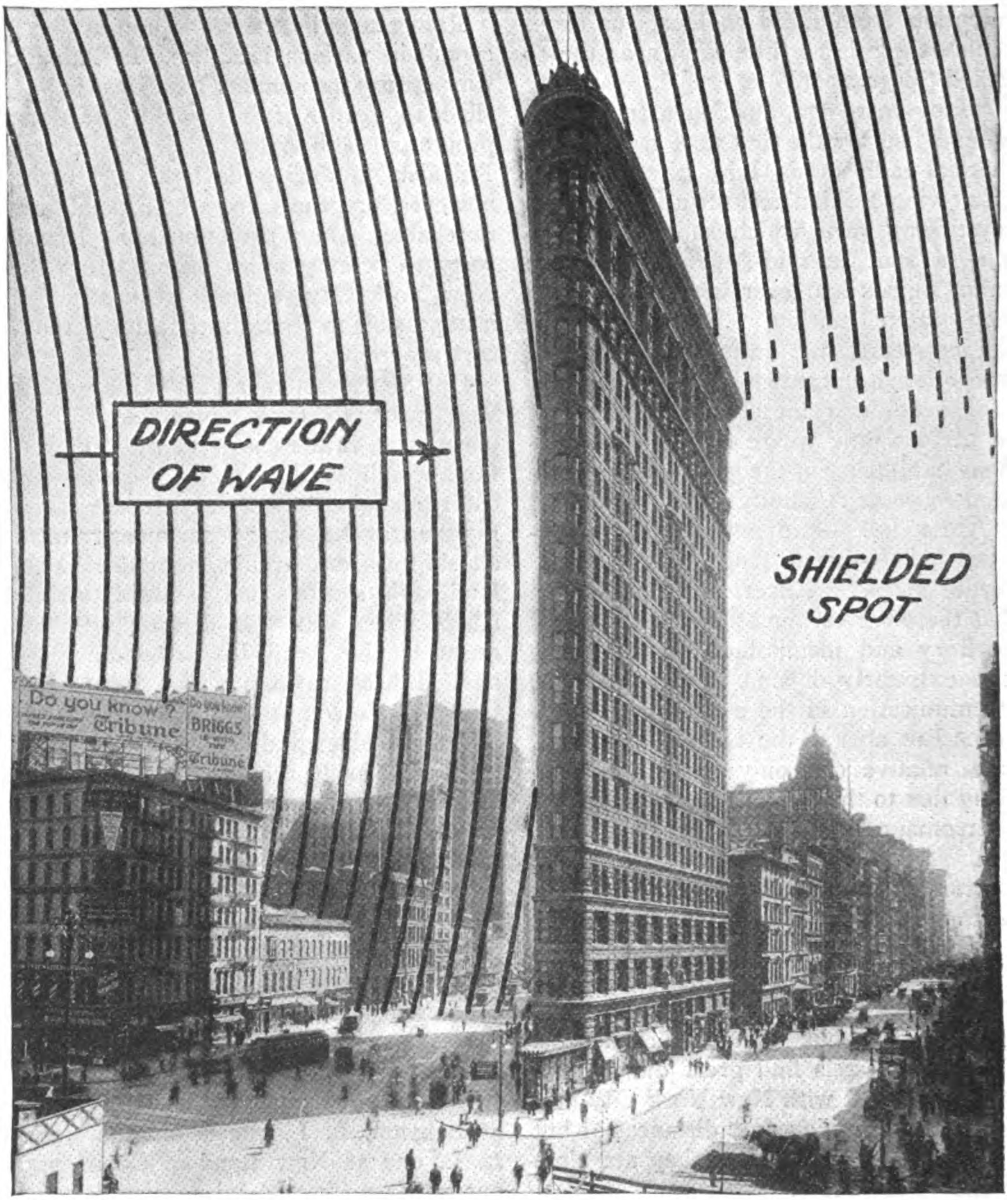
An example of this phenomena which deals with transmission on amateur wavelengths may be cited as follows:

A first class amateur transmitter in New York City finds it possible to communicate directly with a like amateur station in Philadelphia, ninety miles distant, during daylight hours. When darkness falls, the signals of the Philadelphia station become unreadable until late in the evening, and are even then unreliable.

Radiophone listeners, too, report "dead spots" in various localities. In Atlantic City during the summer months it is possible to secure fairly good broadcast programs both from New York and Philadelphia during daylight. At night, however, programs from both points are unreliable. Many points on Long Island, forty to seventy miles distant from the New York City stations, frequently find it impossible to record satisfactory broadcast programs.

During the summer of 1920, an effort was made to take advantage of this phenomena in the choice of sites for stations which were to handle the commercial traffic along the Atlantic coast. During the war the Navy department handled all ship-to-shore traffic, inasmuch as all land radio stations had passed into their hands when war was declared. Subsequent to the Armistice this traffic was handed back to commercial companies. Considerable competition then existed between the older and some newly formed companies as to who should handle the bulk of it. There proved to be a sufficient amount of traffic to make its handling profitable. At least four companies who owned and operated stations within the vicinity of New York were each making frantic efforts to get the better of the other. The most serious difficulty encountered was that of interference between the sending stations.

To be specific, one station at Cape May, New Jersey, two in New York City, one at Babylon, L. I., one at Southampton, L. I., one at New London, Conn., and one on Nantucket Island, frequently tried to establish communication with the same ship at the same time, particularly when that ship would report 200 or more messages ready for transmission. Perhaps one of these stations would receive an acknowledgment from the ship operator whose efforts to get the traffic off were frequently rendered futile because of the interference from the competing stations. Loop aerials and receivers of various types were tried with but little relief.



Brown Bros.

HOW "DEAD SPOTS" ARE CREATED

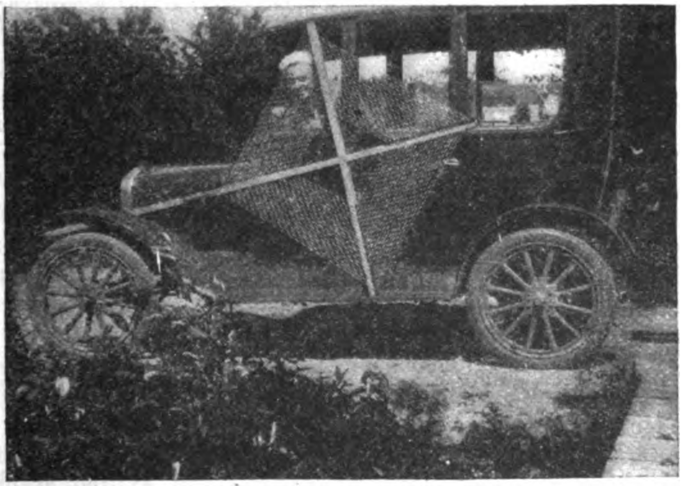
Usually the cause of the trouble is a wall—especially a wall in the form of a building that is largely of metal construction—between your radio receiver and the broadcasting station. Such a structure serves as a shield that deflects the radio waves in much the same way as a ten-foot fence serves as a shield when it intervenes between two men who are conversing. An ordinary crystal or single-tube receiver is usually insufficient to detect the weakened radio waves that do penetrate the shielded areas.

The idea was then hit upon of locating certain points on the North Atlantic coast which would provide comparative freedom from most interfering land stations. The method of locating these "dead spots" proved to be rather ingenious and interesting; to the gratification of those in charge of operations, locations were found where interference from many stations was almost entirely eliminated.

In one of the illustrations which accompany this article (see page 206) is shown a super-heterodyne type of receiver mounted in a Ford sedan. The receiver consisted of a three-element vacuum tube detector, a frequency changer, and a four stage radio frequency amplifier. The car lighting battery was used for all vacuum tubes. However, separate plate potential batteries were used respectively for the detector, the frequency changer (oscillator) and the radio frequency amplier. The circuits of the amplifier were so arranged that the signals could be weakened; that is to say, a certain type of audibility meter was provided. The antenna used consisted of twenty turns of wire on a wooden frame, four feet on a side. The antenna (loop) was so mounted on a rear fender that it could be revolved until pointing toward the transmitting station. Signal strengths obtained with this outfit were equivalent to those which could be obtained on a "T" type antenna, 160 feet high, in conjunction with a single vacuum tube detector and regenerative receiver.

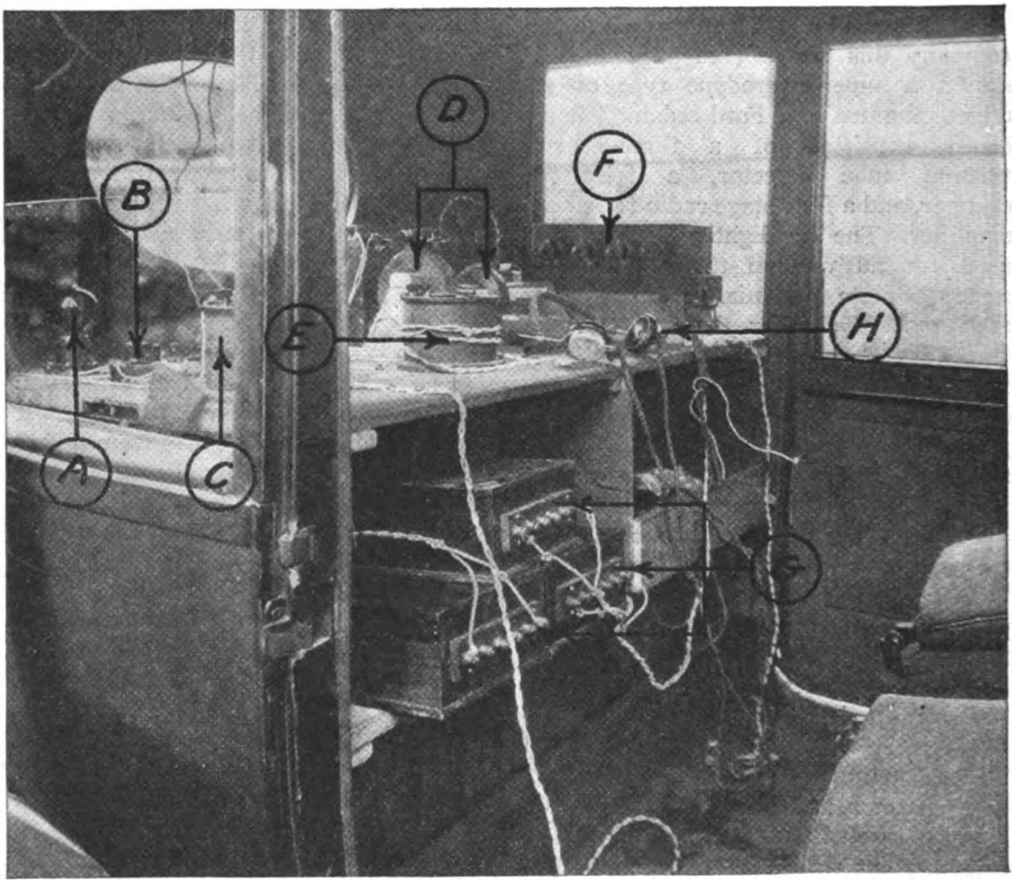
Upon careful study of a topographical map, a point was generally chosen so as to be shielded from the transmitting station by low hills, a rather dense forest, or by a stretch of coast line. Past experience had shown that these usually acted as a shield. At a point near East Moriches, L. I., signals from New York City stations and from New London, Conn., were found to be almost totally inaudible, while signals from the station at Babylon, L. I., were reduced to the point where they would be of no serious trouble. At Smith's Point, some one mile farther toward the Sound, signals from the New York stations, the Babylon station as well as the New London station, were about up to standard. In both positions, signals from out at sea were equally strong. At the Smith's Point location, however, signals from great distances were recorded, as it was possible to read the signals of ships well out at sea and entirely beyond the range of communication of any of the land stations mentioned previously.

As the result of observations in this locality, a receiving station was planned and finally erected. On Cape Cod a point was found near North Truro, Massachusetts, where signals from Boston and Chatham stations were materially reduced. It became necessary at this point, however, to fall back upon large sand dunes for the shielding effect, and an



ON THE TRAIL OF THE "DEAD SPOTS"

The amiable face that peers behind the loop antenna belongs to Paul Godley. The antenna was fitted onto a rear fender during the experiments with radio reception.



THE INTERIOR OF THE RADIO SLEUTH

This extremely sensitive receiving apparatus, which the author installed in a small sedan, includes: A., the vacuum tube used for detection; B, the rheostat for this tube; C, the tuning condenser; D, the honeycomb inductances; E, the heterodyne control; F, the radio frequency amplifier; G, the "B" batteries for the detector, oscillator and amplifier. And, of course, the telephone receivers H.

extremely interesting phenomenon was discovered; a movement of the receiver of only a few hundred feet in either direction caused a marked difference in the strength of signals that came from land stations, while practically no change in signal strength was to be observed in the signals that originated at sea.

Observations taken near the station at New London, Conn., pointed to considerable shielding of this same sort. While signals from New York City stations came in with considerable strength, signals from Long Island and from stations on Cape Cod and near Boston were weak, whereas signals from all vessels in the Atlantic lines came in with what seemed to be doubled strength. It is certain that the exceptionally good work which the station at New London (WLC) has always done is thus accounted for.

It was desirable to locate a third station on the coast of Maine; for this purpose an extended series of observations were taken between Bar Harbor and Eastport. In addition to natural shields or barriers against radio signals from coastal stations, it became necessary in Maine to look, first of all, for a source of power supply. This existed at but few points along the coast. Observations taken at or near Rockland indicated exceptionally good shielding from all transmitters with the exception of the Naval station at Bar Harbor. Ocean-going vessels in the Atlantic lines could be received at this point with great clearness. The Bar Harbor station, however, was a serious drawback and after many experiments along this part of the coast, a point was found near Harrington, Maine, where shielding from both Bar Harbor and Rockland was ideal. Some weakening of signals from ocean-going vessels was to be noticed, however, due, no doubt, to the absorption taking place while the signals were in transit across Nova Scotia.

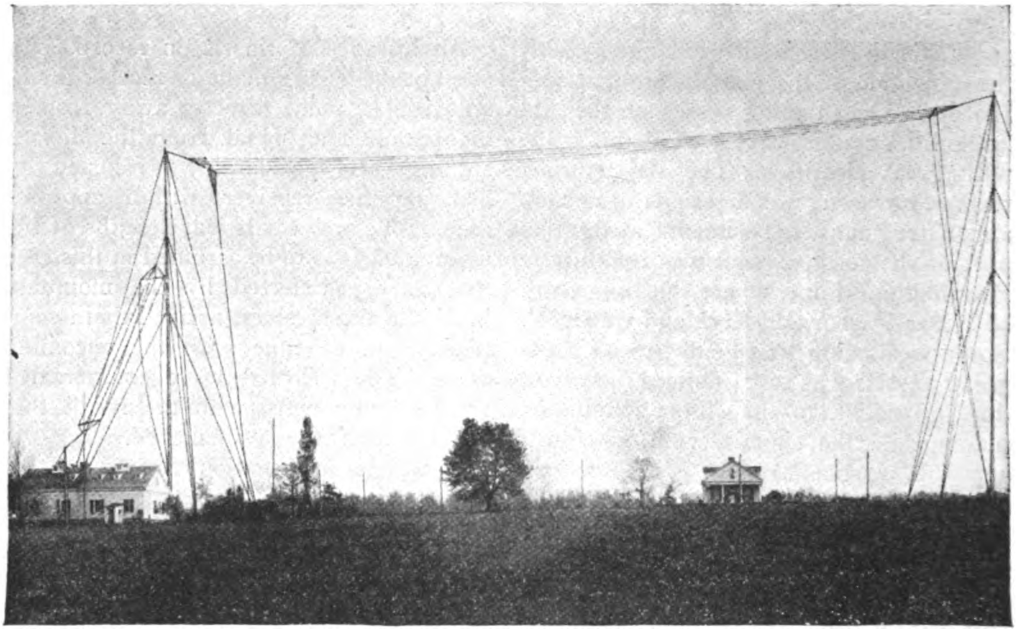
It has long been presumed that hills absorbed or deflected radio signals. Frequently mountains cast decided shadows; so do forests in lesser degree. In the case of the forest, absorption plays the greatest part in the weakening of the signal. Where a chain of mountains exist, the shadowing effects may become quite complex. This is also usually true in the larger cities, due to large steel structures, and is particularly noticeable where communication is being attempted upon the shorter wavelengths. The shorter the wavelength the more pronounced the shadowing effect, for the size of objects such as mountains and groups of trees and tall buildings are of the same order as the dimensions of the radio waves. Where the length of the wave is several thousand meters, few mountain ranges are to be found whose dimensions are sufficient to render them other than relatively small objects in the path of the wave.

Large bodies also act as reflectors. An instance of this is on record. An attempt was being made to receive a signal from a point directly away from a mountain. The signal from the distant station was considerably weakened by bringing the receiver within approximately one and a half wavelengths of the mountain. It is to be assumed in this case that energy reflected by the mountain back into the receiver, arrived there completely out of time with the oncoming wave. The reflected wave counteracted the incoming wave with the result that signal strength was weakened.

Complete information concerning the effects of various objects upon the transmission of radio energy is not now available. When it is, it should be possible to definitely plot the rise and fall of signal strengths over any particular territory. There is little doubt that the "fading" effects observed by so many broadcast listeners are caused by the reflection of the electric wave from layers of gas many miles above the earth. The assumption is that the energy travels up and through the earth's atmosphere to a layer of ionized gas—that the gas reflects the wave, sending it again earthward—that in its travel the wave has encountered nothing which tends to absorb its energies. Suddenly a vapor cloud or a flaw in the reflecting mirror results in the absorption or loss of the signal. These irregularities occur rapidly at short wavelengths in mountainous or hilly countries—less rapidly over level country and at sea, but, under given conditions, the frequency of the fading intervals is a function of the wavelength.

"DETECTIVE BURNS"—

otherwise known as William J. Burns, Director of the Bureau of Investigation, Department of Justice of the United States Government, will shortly publish in POPULAR RADIO *an authoritative article descriptive of the present and impending use of radio for running down criminals, ranging from the broadcasting of warnings to the broadcasting of portraits and fingerprints.*



Chester Radio Club

AN AMATEUR ANTENNA THAT APPROACHES PERFECTION

This flat-topped, inverted L type meets the specifications given in this article to an exceptional degree. It is owned and operated by station 3ZO, in Chester, Pennsylvania.

HOW TO GET THE GREATEST EFFICIENCY OUT OF YOUR

RADIO CIRCUITS

NO. 1 OF A SERIES OF ARTICLES OF PRACTICAL HELPFULNESS FOR THE EXPERIENCED AMATEUR

That one of the world's greatest physicists should prepare especially for POPULAR RADIO such a series of practical, helpful articles on such specific subjects is a matter of importance to radio amateurs everywhere. These articles constitute a real and important contribution to the literature of radio.

By SIR OLIVER LODGE, F. R. S., D. Sc., LL. D.

THE main essentials of a radio installation are capacity and self-induction, or "inductance" as it is commonly known in America, introduced (in the case of a receiving station) in the form of a collector and a detector, and (in the case of a transmitting station) in the form of a generator and a transmitter.

The transmitter and the collector are one and the same thing—the aerial. The transfer from generator to detector is usually effected by a switch. Capacity and inductance are the essential ingredients of an aerial, and it is on them that the wavelength depends. But it is a question what value the capacity and inductance shall have and how they shall be arranged.

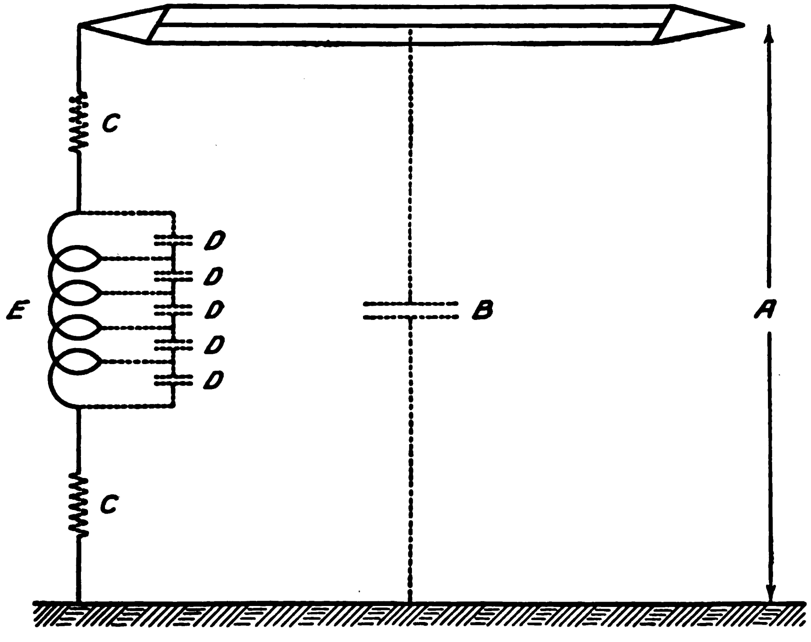
It is obvious that the more open the capacity, the better will it serve as transmitter or collector; hence, whatever capacity is used, it should mainly be in the aerial, in order to attain the highest efficiency. Any defect of capacity in the aerial can be supplemented by a closed adjustable capacity, which of course is very convenient and will always be subordinately required for tuning.

If the aerial could be arranged so as to extend to a great vertical height, its capacity would be as open as possible, and its efficiency as a transmitter or absorber would be correspondingly high; for both the radiating and the absorbing power is proportional to the square of the height. But there are practical limitations to the height that is convenient, so that when the greatest available height is attained any bulk of the aerial beyond that naturally has to be horizontal.

The wavelength, however, depends on the product of capacity and of inductance. So, for any considerable wavelength, if the length representing electric capacity is small, the length representing magnetic induction must be great.

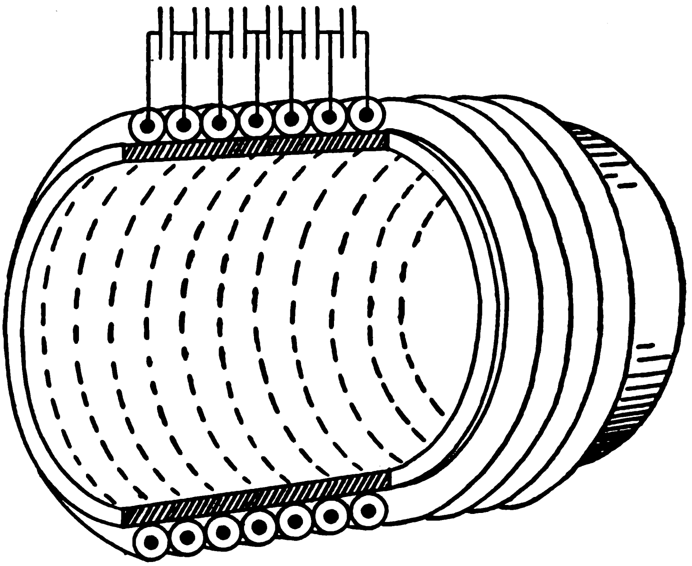
Hence, to get any reasonable wavelength, the capacity of the aerial must be supplemented or reinforced and made effective by a considerable amount of inductance. But whereas the capacity area may with advantage be as extensive as possible, there is no advantage in increasing the mechanical size of the inductance; on the contrary, indeed, there is an advantage in reducing it to a small value, so that quite a minute coil will serve for a great wavelength.

Why should there be this advantage in constricting the inductance coil? Because any capacity which it possesses is useless and to some extent deleterious. There is no gain in mixing up capacity and inductance; they should be kept distinct and separate. The upper part of the aerial, combined with the earth below it, should have all the capacity, and the inductance coil should have as little as possible. Then the wavelength has a chance of being clear and definite. Whatever capacity exists between the turns of the coil has the effect of shunt-



THE THREE QUALIFICATIONS OF YOUR ANTENNA SYSTEM

The height of the antenna above ground, A, should be as great as possible. The upper part of the antenna, combined with the earth below it, should have all the capacity indicated at B. The inductance coil E should be kept as small as possible for a given wavelength, so as to reduce the distributed capacity, D, to a minimum, and the resistance of the circuit, C C, should be kept as low as possible.



HOW DISTRIBUTED CAPACITY CAUSES BROAD TUNING
This diagram illustrates the effect of distributed capacity between the windings of a coil. The insulation between the adjacent turns of wire forms a dielectric and the wire itself forms the plates of a number of little imaginary condensers between the turns of wire. These little condensers have a deleterious effect upon sharp tuning.

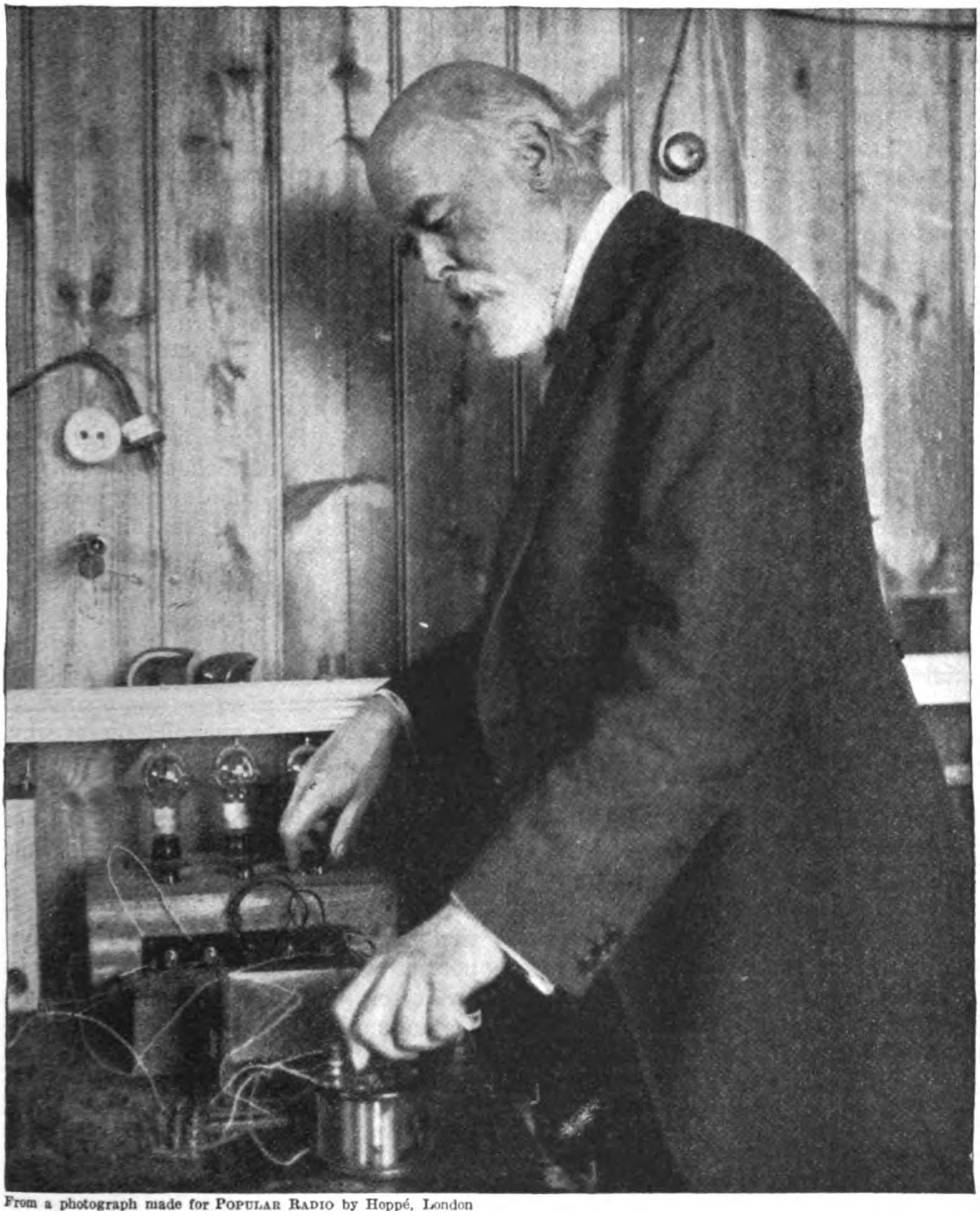
ing some of the oscillation and making it useless. The shunted portions would have any number of indefinite frequencies, and would not contribute to the main wavelength.

This has become known to practical men, and, as a result, what is called *basket* winding has been often adopted, in order that the turns of wire may have some intervening space between them and not lie too close together. Of course this has some effect in diminishing inductance, since the magnetic influence of the turns of wire on each other is slightly diminished. But the reduction in capacity is found to more than compensate this disadvantage, and it is easy enough to get sufficient inductance by making the coil bigger.

Only, of course, then more wire has to be used for the coil; and the more wire it contains, the more capacity it has. So it is evidently a question of compromise, and the best result has to be found by practice. Some capacity between the turns is inevitable; and, apart from basket winding, we may consider how best to secure a minimum of it.

First of all, then, thin wire is indicated; from the capacity point of view the thinner the better. The only disadvantage of thin wire is that its resistance is high. But resistance affects only the damping of the vibrations. And the vibrations are usually sufficiently persistent to cause damping to have no great importance, unless it were excessive. Damping by radiation of energy is inevitable, and moreover it is useful. Other damping is of no use, but it is usually small in comparison. Of course the wire must be of the highest conductivity. But, given that, there is a gain in keeping its thickness very small.

If in any case so much wire has to be used that its resistance does become excessive, then instead of making the wire thicker it would be better to have several wires in parallel. The wires should be very thinly insulated from each other, and then stranded or laid together. A strand of this kind forms a perfect conductor for high frequency oscillations, inasmuch as every part of a



From a photograph made for POPULAR RADIO by Hoppé, London

Sir Oliver Lodge Writes Concerning This Noteworthy Series of Articles—

"I am writing a series of articles for POPULAR RADIO *on points concerning which amateurs would probably be glad to get information. . . . I write not for mathematicians, nor yet for beginners, but aim at boiling down the result of mathematics into popular form suitable for amateurs who want to understand the principles of what they are doing, and who are constructing parts of their own apparatus."*

Oliver Lodge

thin wire helps to carry the current, whereas only the outside of a thick wire is effectively conductive for an extremely high frequency of oscillation; so that the effective resistance of a thick wire is considerably greater than it would appear to be when measured in the ordinary way with steady currents and a Wheatstone bridge. Such considerations do not apply to a strand of fine wires, however thinly insulated from each other they are.

It may be asked, "Why insulate the parallel wires from each other at all?"

But it is clear that if they are in metallic communication, all along their length, they virtually constitute a thick wire. The ether waves cannot then gain access to more than the combined periphery. The inner wires will be screened by the outer ones, just as the interior of a thick conductor is screened; whereas if there is any insulating material between them, however thin, the waves can, as it were, soak in and utilize the conducting surfaces of all the wires. (In this connection it must be remembered that it is the ether, and not the copper, which really transmits the energy; the function of the insulating material is vital.)

Given then as thin a conductor as suffices for the quantity of electricity to be conveyed, the expression for the capacity of such a wire shows that in order to keep it small the turns of wire in a coil had better not lie close together. They can be separated by an air space, or they might be separated by a thick cotton covering outside the real insulation—a covering as airy and uncompact as it can conveniently be made. Basket winding is one way of getting this result, but a thick cotton covering would be another, and would seem to be more convenient.

However that may be, and however the distance between the wires is secured, it can be allowed for in the calculation, and the best method of obtaining the separation can be left to the instrument makers themselves.

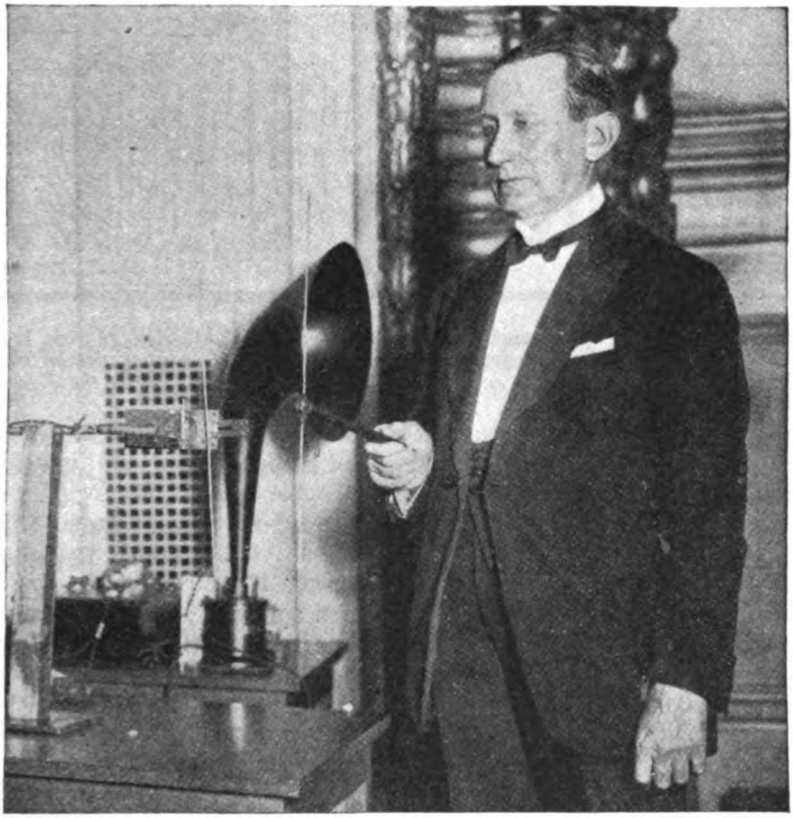
I have not myself, however, found that much separation is really necessary in a receiver. I am inclined to think that its advantage is subordinate and that close winding is quite permissible, as well as certainly more compact, provided certain other considerations are satisfied.

The main consideration is to use as little wire as possible in the inductance part of an aerial; or, in other words, to wind the coil so as to get the maximum inductance out of a given length of wire. This will have a double advantage; it will keep down the resistance, and also it will keep down the capacity—both of which must obviously depend on the length of wire used.

So far as I know, insufficient attention has hitherto been paid to this important consideration, and I doubt if coils are often wound so as to obtain the maximum inductance. I regard this as important, and propose to take it fully into consideration in the articles of this series.

Among the Subjects to Be Covered in This Series Are—

The predetermination of the inductance of coils;
The design of coils for specific purposes;
The relation between capacity and inductance in a circuit;
The qualifications of antennae;
The arrangements of circuits and apparatus for different wavelength ranges.



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THE MAGIC WAND OF THE MODERN MAGICIAN

With such marvelous accuracy may a beam of radio be directed by means of the "projector" which Senator Marconi is demonstrating, that it will actuate relays, one at a time, ring bells and operate receiving sets located at various points in a room as the beam is revolved.

HOW I SEND SIGNALS ALONG

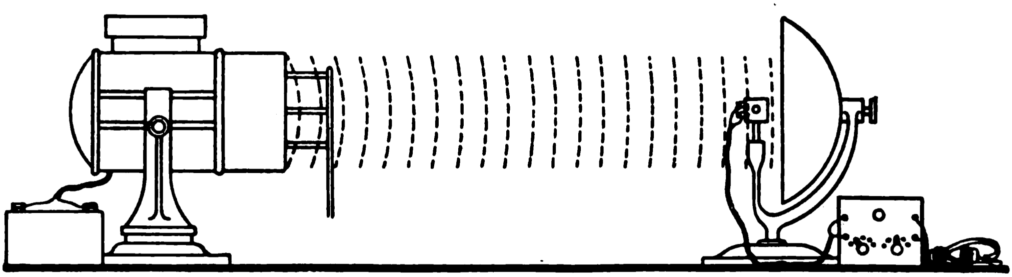
INVISIBLE BEAMS

How the New Short Wave That Can Be Aimed in a Definite Direction is Opening Up a New and Remarkable Assortment of Wave Bands

By SENATOR GUGLIELMO MARCONI, D.Sc., LL.D.

TWENTY years ago I got the simple letter "S" transmitted for the first time across the ocean from England to Newfoundland without the aid of cables or conductors. Those first feeble signals which I received proved once and for all that electric waves could be transmitted and received across the ocean and that long distance radio telegraphy—about which so many doubts were then entertained—was really going to become an established fact.

Radio has already done much for the safety of life at sea, and for commercial and military communication. From now on it is destined to bring new (and until



¶ *A new system of communicating along a beam of light. A light wave is directed in a narrow path from a searchlight and picked up by a reflector which concentrates the waves on a light-sensitive cell which records the signals.*

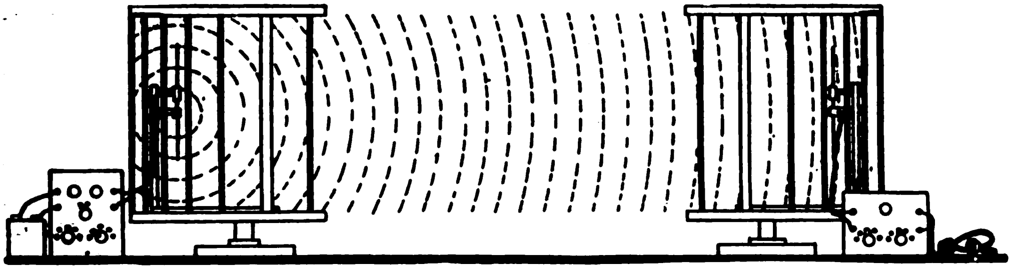
recently even unforeseen) opportunities for recreation and instruction into the lives of millions of human beings. New designs and new uses of vacuum tubes are likely to work quite as many new wonders in the future as they have in the past.

Great possibilities lie in the development of these tubes, especially in their connection with short wave transmission, a somewhat neglected branch of the art. Yet radio waves only a few inches long have many advantages over the waves now used, which range in length up to twelve miles. Such short waves can be more easily moulded to carry the human voice, and receiving sets tuned to them would be less disturbed by static and interference. Indeed, much of my time is now devoted to experiments with the short wave, particularly for use in the secret transmission of messages. So free from interference is this short wave field that I am reminded of my earliest experiments, when the entire field was practically clear and the vast territory of radio was unexplored.

As early as 1899 I showed how it was possible, by means of short waves and reflectors, to project the rays in a beam in one direction only, instead of allowing them to spread all around, in such a way that they could not affect any receiver which happened to be out of the angle of propagation of the beam. I also made tests in transmitting a beam of reflected waves across country over Salisbury Plain in England and pointed out the possible utility of such a system if applied to lighthouses and lightships, so as to enable vessels in foggy weather to locate dangerous points around the coasts. At that time I also showed that a reflected beam of waves could be projected across the lecture room to actuate a receiver and ring a bell only when the aperture of the sending reflector was directed toward the receiver.

Again in 1916 I took up the investigation of the subject with the idea of utilizing very short waves combined with reflectors for certain war purposes; in this work I was assisted by Mr. C. S. Franklin. We used waves only two and three meters long. With these waves disturbances caused by static are almost non-existent; the only interference experienced came from the ignition apparatus of automobiles and motor boats. These machines apparently emit electric waves from 0 to about 40 meters in length; perhaps the day will come when they will be required to have their ignition system screened or to carry licenses for transmitting! During these experiments I observed that one of the short wave receivers acts as an excellent device for testing, even from a distance, whether or not one's ignition system is working right. Some motorists would have a shock if they realized how often their magnetos and spark plugs are working in a deplorably irregular manner.

The transmitting reflector used to concentrate the waves into a ray or beam, in these experiments, was arranged so



¶ *Another new system for projecting a beam. Both the light and the radio beams are dependent on the same phenomena of electromagnetic wave motion. This system uses a radio beam which is invisible.*

that it could be revolved and the effects were studied at a distance with receiving apparatus.

Mr. Franklin has calculated the polar curve of radiation into space in the horizontal plane, which should be obtained from reflectors of various shapes, by assuming that the waves leave the reflector as plane waves of uniform intensity, with a width equal to the aperture of the reflector. The calculated curves agree well with the observed results. Reflectors with apertures up to 3½ meters wavelength were tested and the measured polar curves agreed with the calculated values.

At first the range of the signals was only six miles. Later, on a 15 meter wave generated by an electron tube at the Carnavon station, we transmitted over a distance of seventy-eight miles to one of the mail boats on the Irish coast. The important fact noticed was that there was no rapid diminution of the strength of the signals after the ship had passed the horizon line from Carnarvon. It was easily proved later that clear speech could be exchanged at all times between Hendon (London) and Birmingham, a distance of ninety-seven miles, by using reflectors at both ends.

For these tests, the power supplied to the tubes employed was usually 700 watts. The aerial was rather longer than half a wavelength and had a radiation resistance which was exceedingly high. The efficiency of the input to the tubes to aerial power was between 50 and 60 per cent and about 300 watts could be actually radiated into space. Speech heard with this arrangement is usually strong enough to be just audible with a shunt of from ¼ to ½ ohm across a 60 ohm telephone.

When both reflectors are disconnected and out of use, speech is only just audible with no shunt. Average measurements indicate that the value of the energy received when both reflectors are used and the waves concentrated in a beam, is about 200 times that of the energy received without any reflectors. It would seem that here is one possible solution to secret radio communication, the use of directed beams of magnetic waves.

During the continuous wave tests at Carnarvon, it was found that simultaneous transmission and reception was possible on the same aerial. This system is now being used successfully for duplexing, as it avoids all switching from transmitting to receiving.

Besides giving directional working and economizing power, reflectors are showing another unexpected advantage, an advantage which is probably common to all sharply directional systems. It has been noted that practically no distortion of speech takes place, such as is often noticed with non-directional transmitters and receivers, even when using short waves.

The results between Hendon and Birmingham easily constitute a record for radiotelephony in respect to the ratio of distance and wavelength, as Birmingham is 10,400 wavelengths from Hendon.

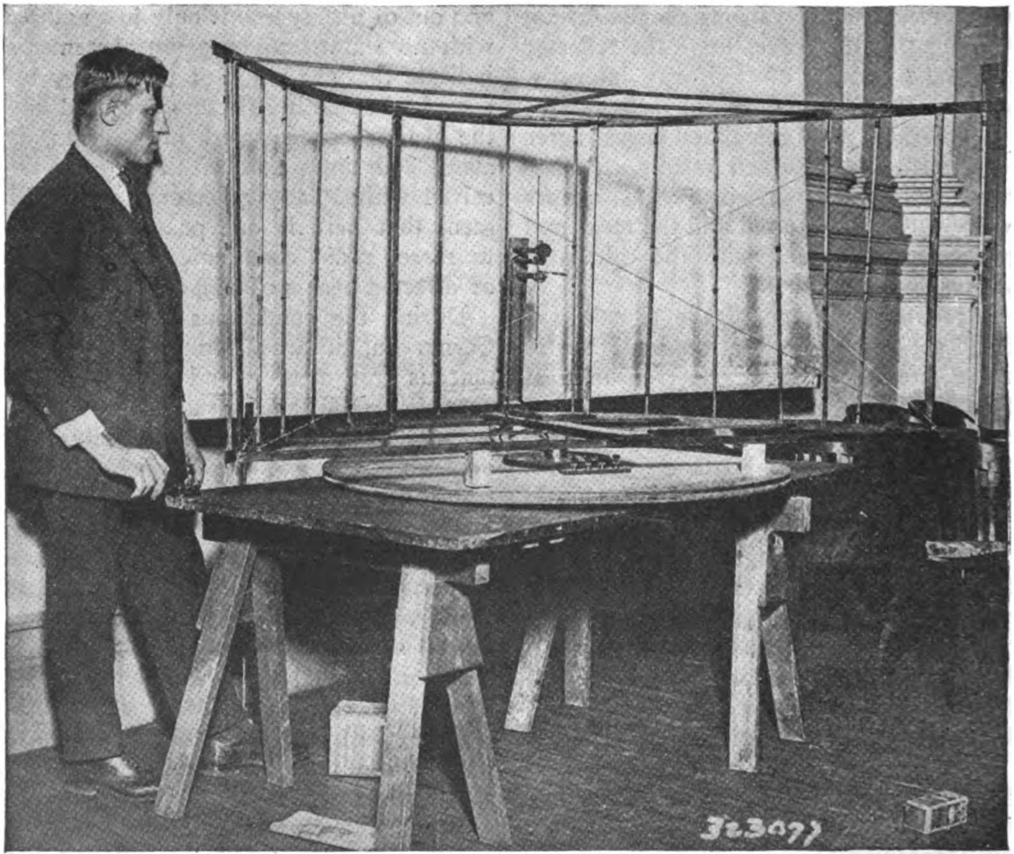
We consider that these results represent only what could be obtained from a first attempt, and not what could now be done by utilizing the experience gained.

A new wireless beacon has recently been developed at Inchkeith Island in the Firth of Forth, near Edinburgh. By means of a revolving directive beam of radiated energy which it produces, ships at sea can ascertain the position of the lighthouse in thick weather. With a 4 meter wave generated by a spark transmitter and a beam reflector, signals have been sent which were readily distinguishable on a ship seven miles away fitted with a single tube receiver. The reflector made a complete revolution every two minutes, and a distinct signal was sent at every half point of the compass. This enabled the ship to determine the bearing of the lighthouse accurately within a quarter point of the compass, or within 2.8 degrees.

With the revolving beam the exact periods of maximum reception are not easy to judge by ear, but the times of starting and vanishing are easy to determine, as the rate of rise and fall of the signals is extremely rapid.

By means of a clockwork arrangement a distinctive letter is sent out every two points and short signs mark intermediate points and half points. This is done by contact segments arranged on the base of the revolving reflector.

These short directional waves resem-



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A WORKING MODEL OF THE MARCONI REFLECTOR

This is the apparatus for concentrating the radio rays in one single beam. The small vertical object at the center of the reflector is the oscillator. The length of the waves propagated by this miniature antenna system is only about one or two meters.

bling a beam of light decrease in strength so gradually when traveling over water that the distance of the transmitting station may readily be estimated.

Still another help to navigation may be found in the reflected beam wave. Hertz showed that electric waves can be completely reflected by sounding bodies. In some of my tests, I have noted the effects of reflection and deflection of these waves by metallic objects miles away.

It seems to me that it should be possible to design apparatus by means of which a ship could radiate or project a divergent beam of these invisible rays in much the same manner as a searchlight, in any desired direction so that if they should meet another ship they would be reflected back to a receiver screened from the transmitter. This would reveal the presence and bearing of nearby ships in fog and heavy weather, even though such ships were not provided with radio equipment.

"SECRET MESSAGES CAN BE SENT BY RADIO"

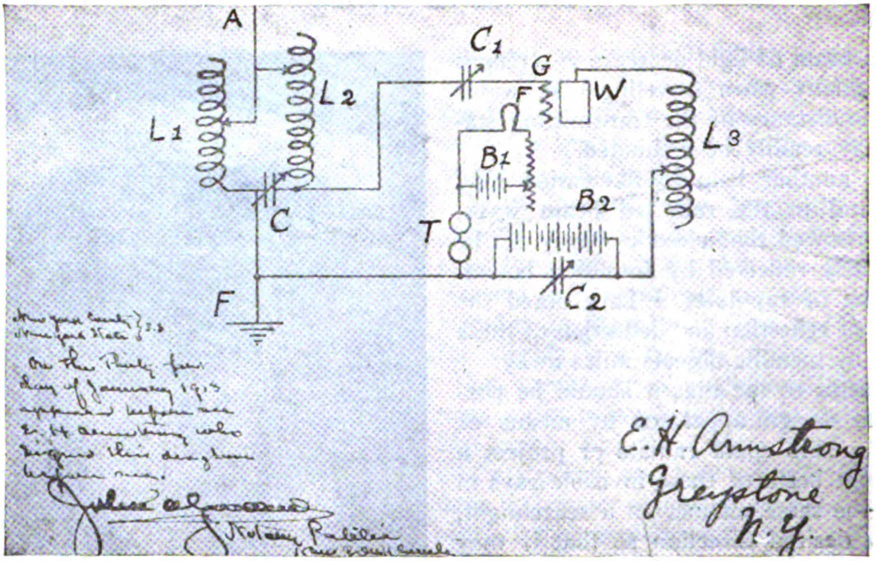
So states Senator Marconi, whose recent experiments with short waves (some of them only a few inches in length) that can be focused like a beam of light is opening up a line of development in radio communications that has heretofore been regarded as closed. This picture of the Senator was snapped by Paul Godley during a visit to the Marconi yacht, "Elettra," which is practically a floating radio laboratory.

From a photograph by Paul Godley

"Stations I Have Heard"

In the next number of POPULAR RADIO—April—will start a new department that will tell, in brief paragraphs, of some of the exceptionally good results obtained by amateurs and novices from their receiving sets and how they get them.

If you are getting exceptionally good results from *your* set—tell POPULAR RADIO how you do it!



New York County } s.s.
New York State }
On the Thirty first day of January 1913 appeared before me E. H. Armstrong who signed this diagram before me.
Julius
Notary Public
New York County

E. H. Armstrong
Greystone
N. Y.

A SKETCH THAT MADE A FORTUNE

When young Armstrong wisely brought it to a notary public to be attested, he established a priority claim to his invention of the feedback circuit—a claim that was upheld by the courts.

A Hook-Up for $500,000

In this article Dr. Henry Smith Williams, *himself a distinguished scientist, tells how a radio amateur hit upon an idea for a "feedback" circuit and stuck to it till he proved that "there was a fortune in it—"*

EDWIN H. ARMSTRONG

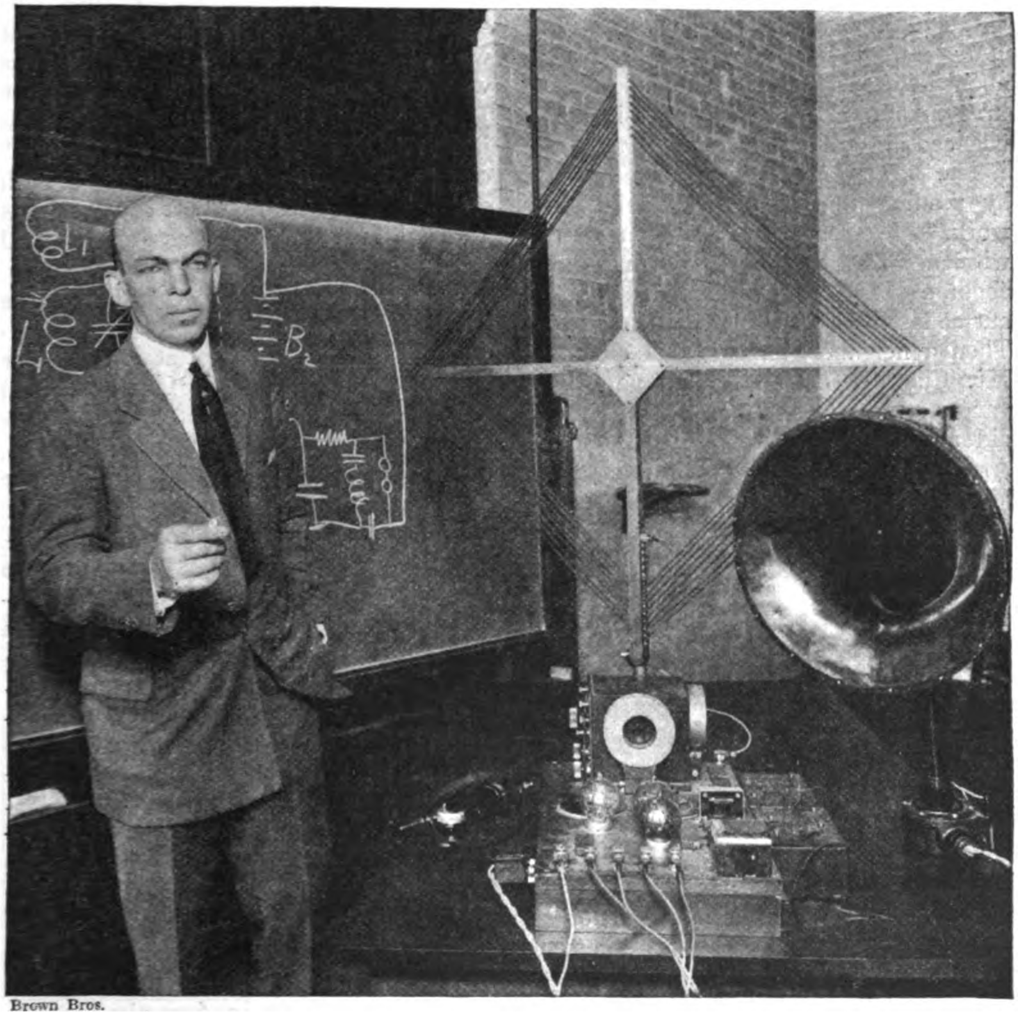
RADIO, as young America has tackled it, is the most wonderful game that the youth of any generation has ever played. As informative as it is fascinating, it comes near to nullifying the age-old edict that there can be no royal road to learning. For the young enthusiasts who are playing this game are at the same time becoming trained mechanicians and thoughtful students of electrical phenomena; in due course they will open up new fields of radio practice that are at present unknown.

The prophecy that within ten years there will be a radio receiving telephone in every home that now has a phonograph, and in most homes that now have telephones, seems not in the least hazardous. Scarcely more so is the prophecy that within fifteen or twenty years it will be almost as customary to carry a little radio receiving telephone apparatus in your pocket as it is now to carry a watch. If these prophecies, and others in kind, become realities, it will be largely because many thousands of American youths learned to play the radio game almost in childhood, and in so doing were given the opportunity to demonstrate the possession of inventive talents that otherwise might never have been suspected.

One might be disposed to say that radio is essentially a boy's game at which men who remain perennially young may play. It gives full opportunity for use of the imagination and for the manifestation of inventive ingenuity, and youth is essentially the time when imagination has free play. Only the young—including a few rare mortals who never grow old—have the imagination and the temerity to attempt the impossible; to believe in miracles—and to achieve them.

The proof of this, were proof needed, may be found in the history of radio development. Young Heinrich Rudolf Hertz, called the father of radio, found the first definite clues; young Guglielmo Marconi—at the age of twenty—made the first convincing demonstrations; young Lee De Forest perfected the magic tube that is the heart and soul of the modern radio apparatus; and young Edwin H. Armstrong performed the final feat of jugglery that permitted the necromantic bulb to reveal its ultimate miracles. There appear to be no old men in the story.

Everyone knows something of the achievements of the first three of the



Brown Bros.

"FEEDBACK" ARMSTRONG DEMONSTRATES HIS LATEST TRIUMPH

Radio engineers and scientists have realized the limitations of the regenerative circuit, although still recognizing its superiority to other known single-tube circuits. But Armstrong has recently come forward with the super-regenerative circuit (pictured above)—the first circuit to overcome these limitations.

pioneer workers in radio just named. Here I wish to refer to the remarkable work of the fourth member of the *coterie*—partly because of the news interest associated with the fact that the long series of litigations that have grown out of his discovery has just been terminated; but chiefly because it seems fitting that every user of a radio receiving telephone should know the story of the youth who played the radio game so well as to make possible its application for the foundation of the art of broadcasting.

Only a short time ago, in the year 1906, Armstrong was a sturdy boy of about fifteen, at the home of his parents, in Yonkers, New York, enthusiastically engaged in the then new radio art.

The boy's interest had been aroused by reading reports of Marconi's early work. He set to work to construct a wireless apparatus of his own. For about a year he worked unsuccessfully, but at last he began to receive messages. Then a neighbor, an electrical engineer, Mr. Charles I. Underhill, gave him a vacuum tube, which the donor himself did not know how to operate. Young Armstrong soon found out the secret, however, and presently he went on to experiment with the new type of electron tube, the audion, which Lee De Forest had introduced in 1907. The earlier tube had been of the type called the Fleming valve. It was after he had gained full mastery of the use of the audion tube, as then understood, that young Armstrong, a college student at Columbia, was led in the course of experiments with the current from the local plate battery (the "B" battery as it is now called), to attempt to augment the incoming, message-bearing current from the aerial by "feeding-back" a portion of the local current into the grid-filament circuit.

The thing worked out better than he could possibly have anticipated and presently he was aware that he had made an important discovery. What he had done, as the sequel showed, was to invent the apparatus afterward called a "tickler coil," establishing the now famous "regenerative" circuit.

The young inventor could not secure financial backing to have his device patented at the moment; but he made a diagram (what is technically called a "hook-up") of the apparatus as he had modified it, and went before a notary in January, 1913, to have his signature on the sheet showing this diagram officially authenticated. It was a fortunate thing for him that he did so, because this simple document was the most important witness in the long series of litigations which resulted in the final verdict by the United States District Court of Appeals in which the "Feedback Armstrong's" claim to rank as the discoverer, with ownership of the important patent rights appertaining thereto, was given final legal recognition.

On another occasion, we will examine in detail the technical aspects of this remarkable discovery. Let it suffice here to cite the comment of Professor Michael I. Pupin, in whose laboratory at Columbia University young Armstrong worked, to the effect that the invention of the feedback, in itself of vast importance, led the young inventor also to make another most important step in radio telegraphy—the construction of the vacuum-tube oscillator. Professor Pupin declared that one large electrical corporation is now engaged in experimentation with powerful vacuum-tube oscillators with an output of upward of fifty kilowatts. "Such tubes have practically unlimited possibilities in communication," said Professor Pupin, "while their application in other industries will in the near future result in some revolutionary changes of vast importance."

Note, then, this further comment, as pertinent to our present theme:

"In this case, as in (practically) the case of every other important invention," said Professor Pupin, "it is the student who produces the original idea and not the research laboratories of the big cor-

Brown Bros.

"THE MAN WHO MADE LONG-DISTANCE TELEPHONY POSSIBLE"

This term has been applied to Michael I. Pupin, professor of electro-mechanics at Columbia University, in whose laboratory Edwin H. Armstrong studied. Like his famous pupil, he also received a vast fortune for an invention known as "the Pupin coil."

porations. The latter do some wonderful and important work, especially in refinement and development of inventions, but the conditions of efficiency under which they work hamper their originality.

"You can't get a man like Armstrong to punch a clock. In fact, I know he was fired for refusing to punch a clock—but I took him in at Columbia."

The narrator who reports the conversation goes on to say that Armstrong himself, who was present, laughed and declared that he had just "one more thing to put over," and that then he meant to retire for the time being and go over to Europe for a rest. He would not say what the nature of the "one more thing" might be; but perhaps an inkling as to its character may be gained from another interview with the now famous inventor. In this interview, Armstrong makes the prophecy that the radiophone receiver will be as common in the not distant future as the victrola now is.

"Not every home will have a radiophone, of course," he said, "but I can predict that every home having a phonograph will be equipped with radio."

This equipment, it is further prophesied, will consist of none of the outside and unsightly wires, switchboards, and batteries now seen at every radio station. The whole radiophone receiver, horn and all, will be no larger than the now ordinary music box, and the current to operate it will be supplied by electric cords, connected with the nearest wall plug. Instead of the aerial wires that are now used the radiophone receiver will have a small coil of wire or a metal rod five or six feet long, something no more conspicuous than the ordinary curtain rod. Outside wires will be unnecessary.

Armstrong himself has this sort of equipment in his home at Yonkers even now. He has set up there a small receiver that employs no outside wires and which picks up music and other signals from the broadcasting station at Newark with such strength that they may be heard half a mile away.

There is nothing remarkable about this, from the standpoint of the inventor himself, except the fact that this receiving apparatus has no outdoor aerial. As long ago as 1915 the young experimenter could describe the results with his then newly discovered "feedback" apparatus in these words, addressed to Mr. Underhill, the engineer who had supplied him with the vacuum-tube:

"During the past four months I have worked up a number of improvements on the audion detector and I believe that I have a receptor which is from two to three times as sensitive as any other, and this is a conservative estimate. With this receptor I can hear every navy station on the Atlantic Coast from Cape Elizabeth, Maine, to Colon, Panama, including Guantanamo, Cuba, with the telephone receiver lying on the table. The Florida stations are so loud that they can be heard all over the room, and on good nights, Key West can be heard down on the floor below."

In writing thus, the young inventor was giving an account of results attained with a method which he has since made available for all the world. In the words of a writer in the New York *Tribune,* "no transatlantic telephone conversation can be carried on without the Armstrong principle, nor can any of the big radiophone broadcasting stations now sending music nightly through the ether operate without using the Armstrong patent. Even the modern multiplex forms of wire telegraphy and telephony (wired wireless) must use the Armstrong method."

That is what has come from the efforts of the boy who started out to play at the radio game when his companions were chiefly concerned about baseball and other outdoor sports. When the man who has done these things chooses to enter the field of prophecy the entire radio world must listen, and few will be disposed to question that his prediction as to a compact radio telephone receiving apparatus, without aerial or other cumbersome accessories, will presently be realized.

POPULAR RADIO'S CHANCE TO RENDER SERVICE

POPULAR RADIO can perform an important public service by helping to solve the problems of radio broadcasting. . . .

It is obvious that the only power which can establish adequate "rules of the road" is the Federal Government. Eventually we should have a national system, the cost of which would be maintained by taxing all stations according to their sensitivity. Before this can be secured, however, it will probably be necessary for private initiative to organize a system of high-calibre stations for broadcasting throughout the country, with an extensive system of membership and membership dues for receiving stations.

—J. W. MACCRACKEN,
President, Lafayette College

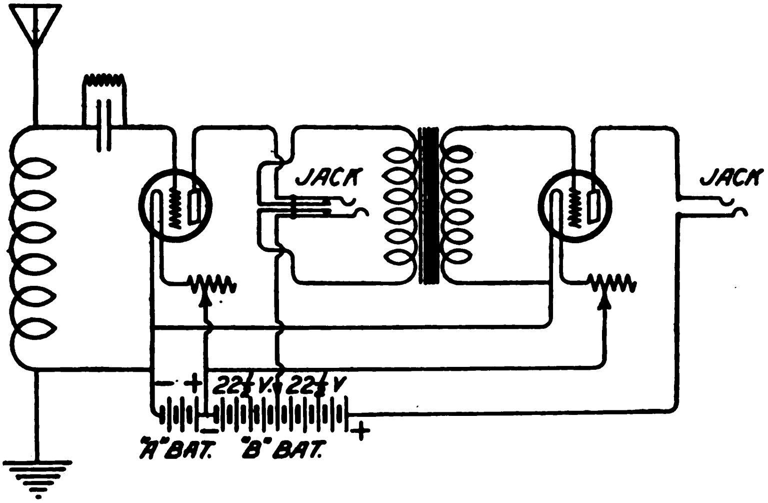


FIGURE 1

This is a circuit for adding one stage of audio frequency amplification to a straight audion detector circuit employing a tuning coil for tuning.

How to Make a One or Two-Step AUDIO FREQUENCY AMPLIFIER

The Eighth of a Series of Practical "How to Make" Articles for the Radio Amateur

By A. HYATT VERRILL

WHILE many radio enthusiasts make their own sets, which are fairly successful, many seem to think that they must purchase amplifiers ready-made. In reality, however, there is nothing mysterious, complicated or difficult about making an amplifier of one or two stages. In fact, a one-step amplifier is just as simple and easy to make as an ordinary tube set.

In making an amplifier the instruments cannot, of course, be made at home—the rheostats, audio frequency transformers and tubes are not devices which an amateur can construct. But there are, in addition, the wire binding posts, plugs and similar accessories, and the person who constructs his own amplifier has ample opportunity for exhibiting his skill and workmanship, both in the wiring work and in mounting the instruments on a panel or in a cabinet. There are, moreover, certain rules which must be borne constantly in mind when constructing an amplifier, or otherwise the device will not work efficiently.

In the first place, all connections *must* be tight and soldered; there should be no loose connections, no loose binding posts and no careless, sloppy work. Connections and joints which might pass unnoticed in a receiving set with just one vacuum tube will result in howls, squeals and other noises in an amplifier, for it must be remembered that sounds due to any loose connection or fault are magnified just as much by an amplifier as are the signals that should be heard. And the more steps there are the more these faulty sounds are magnified; hence the more carefully the instruments must be made.

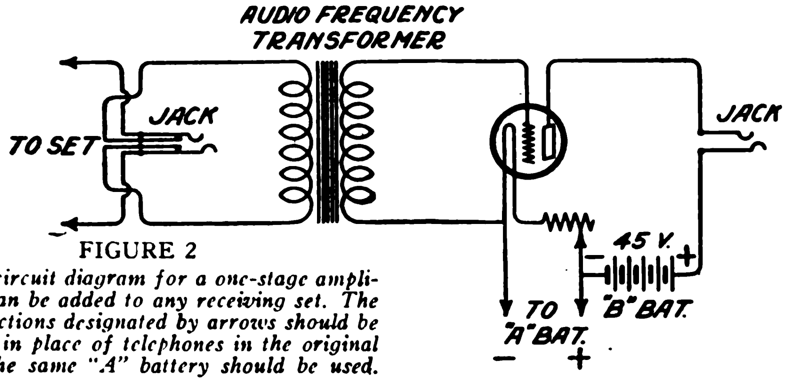


FIGURE 2

This is a circuit diagram for a one-stage amplifier that can be added to any receiving set. The two connections designated by arrows should be connected in place of telephones in the original set, and the same "A" battery should be used.

In the second place, if more than one stage of amplification is used, the iron cores of each successive transformer must be placed at *right angles* to the one preceding it. This is important in order to separate the magnetic fields.

In the third place, all wires should be kept as short as possible. They should not be run parallel if it can possibly be avoided, and where two wires cross they should be kept well separated.

The simplest amplifier to build is a one-step such as is shown in Figure 2. Although it is best to build it as a separate unit with a telephone jack attached to the wires which are led to the detector set, the amplifier may, if desired, be built on a single panel with the set, Figure 1. By using a jack as shown, the set can then be used either with one tube or with the amplifier using additional tubes. By merely inserting the telephone plug in the first jack, the contact with the amplifying transformer is broken and the detector tube alone is used, whereas, by removing the plug and inserting it in the second jack an additional vacuum tube is used as an amplifier. If a second stage of amplification is desired, it may be built exactly like the first and connected as shown in Figure 3. The amplifier may be arranged so that either the receiving set alone can be used or one or both stages of amplification, by merely inserting the phone plugs in the correct jack. When the amplifier is used in connection with the detector set, either the same *A* battery or separate batteries may be used; this is the case also with *B* batteries.

In using the amplifier, bulbs or tubes made for the purpose must be used; amplifying bulbs are practical for use as detector bulbs, but detector bulbs do ***not*** give as good results for amplifying. It should also be borne in mind that the only adjustment required in the amplifier is

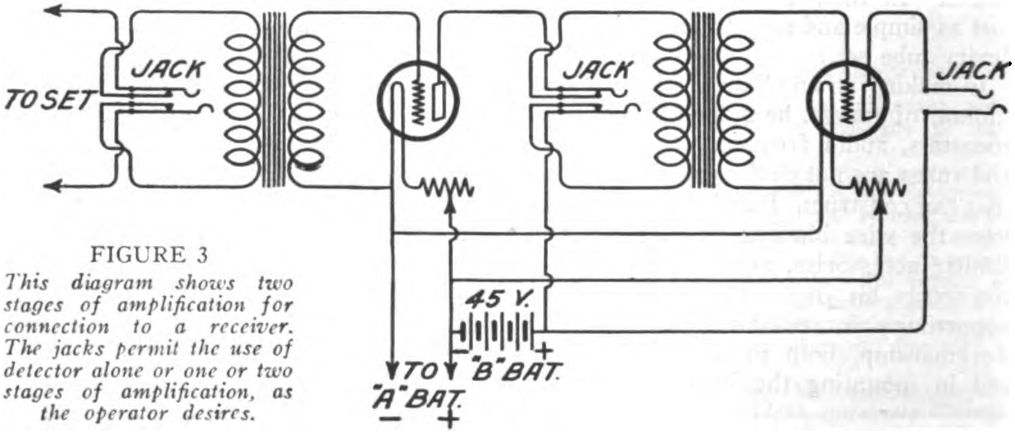


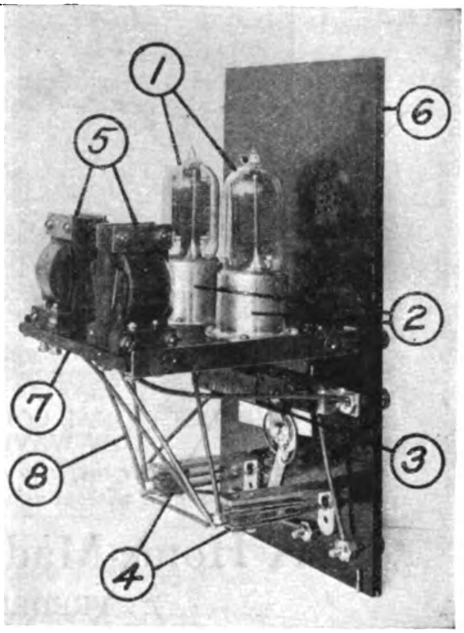
FIGURE 3

This diagram shows two stages of amplification for connection to a receiver. The jacks permit the use of detector alone or one or two stages of amplification, as the operator desires.

the rheostat, and that while amplifiers may be constructed with a single rheostat control for several tubes, far better results are obtained by having a separate control for each filament. Bulbs often vary in quality and, as a variation in the filament adjustment will result in a variation in sound volume, care should be exercised in keeping the filaments adjusted to the right degree of brilliancy.

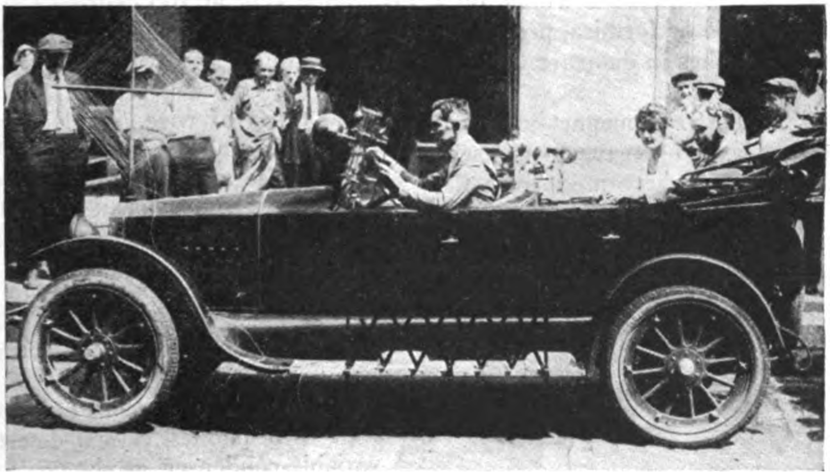
As a last word of advice, it should be remembered that each step of amplification magnifies greatly the received energy; therefore it can readily be understood how important it is that no undesirable sounds or noises, due to loose connections, come in. Of course, the amateur builder may make his set up on a board or in a cabinet as it suits his taste, but as long as the precautions outlined in this article are observed and the wiring diagrams followed in connecting up the set, good results will be obtained.

The accompanying photograph will probably suggest one solution to the amateur who is undecided as to the form in which to make the set.



HOW TO MOUNT THE SET

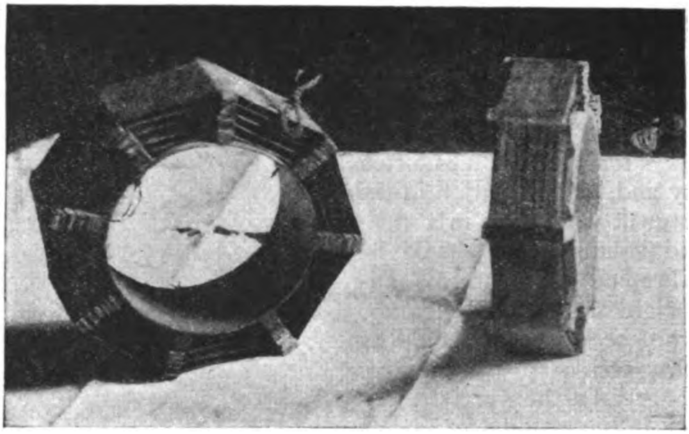
The parts are: 1, amplifying vacuum tubes; 2, tube sockets; 3, filament rheostats; 4, jacks; 5, amplifying transformers; 6, front panel; 7, shelf for mounting the instruments. The diagram for wiring this set is shown in Figure 5.



International

LONG-DISTANCE RECEIVING ON A MOTOR CAR

A Chicago radio fan, Paul D. Coats, has equipped his touring car with an Armstrong regenerative receiver and has placed his loop antenna out of the way on the radiator cap. While motoring about the streets of Chicago on his way to and from business he hears stations all over the country, some of them as far distant as Newark, N. J.



THIS OCTAGONAL COIL RECEIVES BOTH HIGH AND LOW WAVELENGTH SIGNALS

This type of inductance is simple to make, and makes possible the reception of high wavelength signals without using the more cumbersome simple layer coils.

A Home-Made Multi-Layer Coil

BY FREDERICK J. RUMFORD

A MULTI-LAYER coil which is much more efficient than the ordinary layer-wound coil and which is a rival of the honeycomb coil can be made easily at home and with little cost. Such a coil serves well in a regenerative set and can be used to advantage in other hook-ups where inductance is required.

The most practical size is wound on a form of cardboard or formica, preferably the latter, 3¼ inches in diameter and 1¼ inches in length.

Use No. 24 D. S. C. magnet wire and wind the first layer upon the form itself. The second layer is separated from the first by a gap of ¼ inch, made by eight blocks of cardboard ¼ inch square and 1¼ inches long, spaced evenly around the form. In winding the second layer, cross the wire back to where the first layer was started and continue the operation until six layers have been wound.

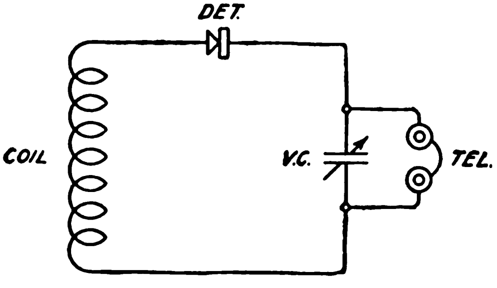


Figure 1

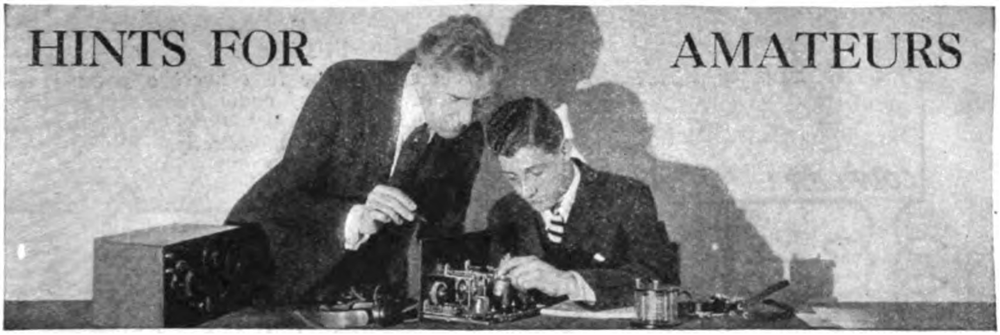
A circuit that employs a multiple-layer coil as a wavemeter inductance.

When the coil is wound, emerse it in parrafine kept at 100 degrees Centigrade until it ceases to bubble, then hang it up to dry. For a wavelength up to 360 meters the coil will require between 35 and 50 turns of wire. Coils for higher wavelengths require more turns. A coil is shown in the accompanying photograph.

With three such coils an efficient regenerative receiver can be made with but little cost. Place bands of fibre around the coils and attach them to blocks mounted upon hinges so that they will swing like honeycomb coils and make the coupling variable.

When one of these coils is placed in a circuit with 'phones, crystal detector and a variable condenser, as shown in Figure 1, it forms an efficient wavemeter. The coil can be calibrated with a standard wavemeter and a curve chart made to show the different wavelengths.

HINTS FOR AMATEURS



It is sometimes necessary for the amateur to bore holes in the edges of insulating panels in order to mount or attach them to another panel. The inexperienced fan often finds that it is almost impossible to do this well, as the panel splits when hte drill is applied to the edge.

The panel splits because the insulating materials are (most of them) built up of layers of impregnated sheets of paper, which are pressed together in a hydraulic press into a solid mass. If the amateur will put the panel in a clamp as shown in the diagram (Figure 1) so that the layers cannot separate while drilling, he will find that it is just as easy to drill into the edge as into the face of the panel.

* * *

In designing radio apparatus, for either sending or receiving, do not place high frequency instruments within the field of low frequency instruments or parts. If you do, they will interfere with each other. For example:

If an audio frequency amplifying transformer were to be mounted close up to a variocoupler or any other radio frequency tuning apparatus, it would seriously interfere with the tuning of the set. This is because the iron core in the amplifying transformer has a much greater "reluctance" than the air core of the tuner, and the iron thus being within the field of the tuner produces an effect similar to the addition of resistance in the coils of the tuner. The effect of reluctance in a magnetic circuit is somewhat similar to what resistance is in an electric circuit.

The radio frequency apparatus in a circuit should be separated from the audio or low frequency apparatus in the circuit and all wires of circuits of different frequencies should be kept well apart to prevent inter-action and inter-reaction between them.

* * *

Do not let the telephone cord droop off the table and come into contact with the top of the storage battery, as there is always more or less strong acid on the top of the battery which will eat away the cloth covering on the telephone cords and allow the wires in them to short-circuit and thus make a lot of crashing, crackling sounds in the telephones.

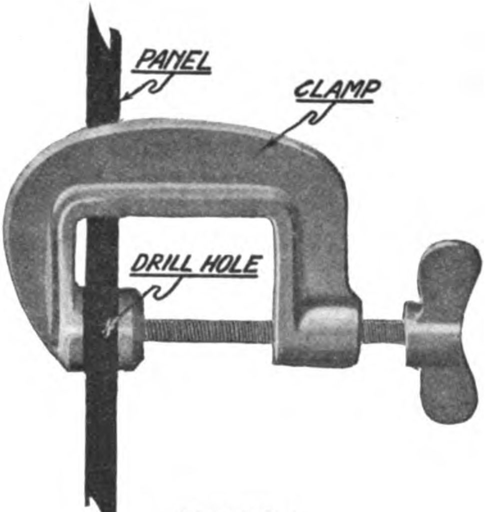


FIGURE 1

Use a small clamp such as this to prevent "splitting" when drilling in the edge of a panel.

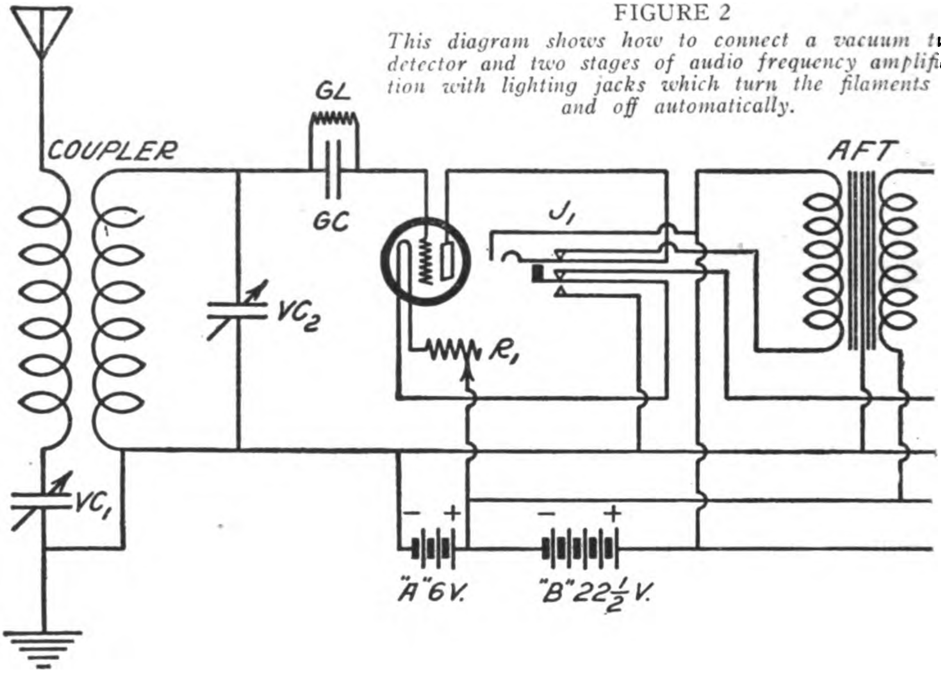


FIGURE 2

This diagram shows how to connect a vacuum tube detector and two stages of audio frequency amplification with lighting jacks which turn the filaments on and off automatically.

In building a home-made audio frequency amplifier, the amateur often experiences trouble from a phenomenon generally known as "howling." This is a peculiar effect produced by reaction between the successive stages of amplification, which results in loud whistling noises and squawks which drown out the signals. It may be prevented or eliminated by the observance of the following precautions:

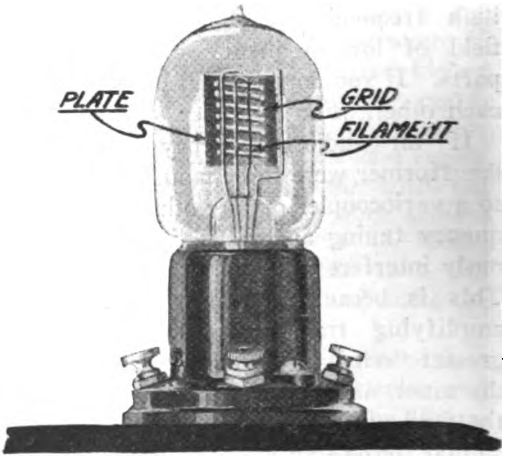
1—Place all the amplifying transformers in such positions that the iron cores upon which they are wound will be at right angles.

2—Ground all the iron cores of these transformers. See diagram on this page (Figure 2).

3—Try reversing the primary wires running to the transformers, listening in after each change until the correct connection is found and the amplifier functions without extraneous noises.

* * *

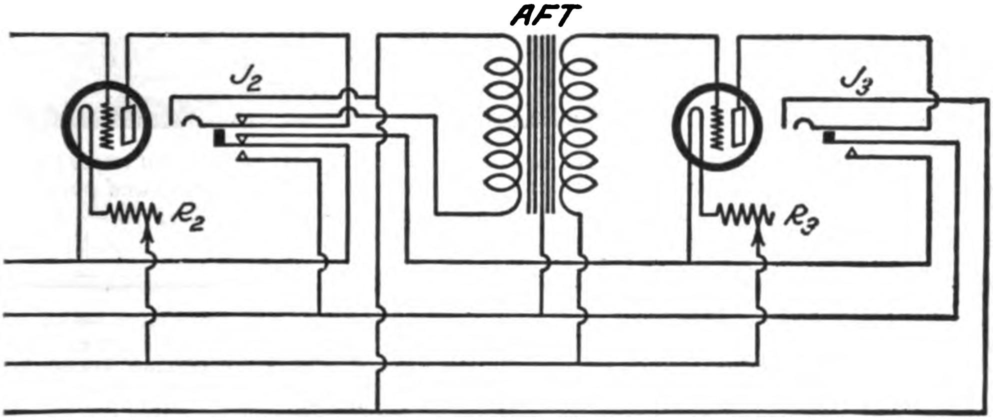
Vacuum tubes should always be mounted vertically. This is because the filament wires in most American tubes are supported vertically in the tubes. Tubes mounted horizontally, sticking out from the face of the panel, have their filaments strung horizontally, and they will sag and may finally lean down far enough to touch the grid, when the tube will become inoperable.



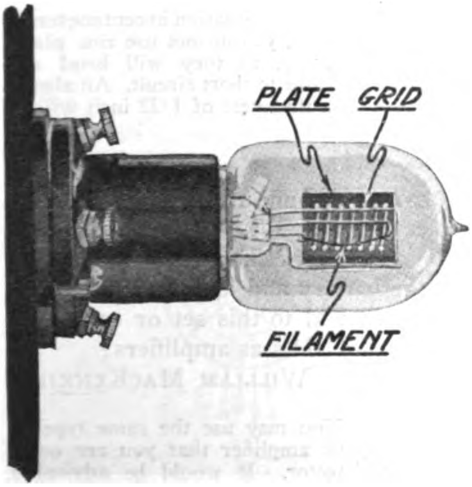
THE RIGHT WAY TO MOUNT A TUBE

Tubes mounted in this position maintain the filament in a vertical position and eliminate the possibility of sagging.

Most experienced amateurs realize the advantages of using automatic-filament-lighting-jacks. These jacks are used to "cut in or out" the number of vacuum tubes used in a receiving set. When they are used with a detector and two stage amplifier, three jacks are necessary, one for the detector, the second for the first stage and the third for the second stage. The jacks for the detector and for the first stage are called "double-circuit jacks," and the one for the second stage is known as a "single-circuit jack."



The automatic jack has this one great advantage over the ordinary jack; it takes care of the complicated switching of the plate and filament circuits in a single action. When the telephone plug is inserted into the detector jack the filament of the detector tube automatically lights up; when it is inserted in the first-stage jack the two tubes light up; when it is inserted in the second-stage jack the three tubes light up; but when the plug is extracted all the tubes go out. The automatic jack in no way interferes with the proper action of the filament control rheostats.



THE WRONG WAY TO MOUNT A TUBE

Tubes mounted in this position are liable to cause the filament to sag and touch the grid, in which case the tube will cease to function.

Many amateurs and beginners who consider using this new type of jack are deterred by a glance at the terminals, which are six in number. The average amateur doubts that he would ever be able to find out where all the connections go. This will be easy if the diagram as shown (Figure 2) is followed. The jacks are designated as J1, J2 and J3.

* * *

Do not let your storage batteries run down dead, as this misuse will soon cause deterioration and the battery will be no good. When your battery shows signs of dropping, take it to the garage and get it recharged. Better yet, obtain a charging device and keep it always charged yourself by turning on the charger after you have used the set. The charging device will quickly pay for itself, as the battery lasts longer and you will save the money paid to the garage for charging.

WHAT READERS ASK

This department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. **Confine each letter of inquiry to one specific subject.**
2. **Enclose a stamped and self-addressed envelope with your inquiry.**
3. **Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.**

In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our *subscription list*. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.

QUESTION: Would it be possible for me to use a hard amplifier tube for a short-distance C.W. transmitter? If so, what voltage "B" battery should I use on the plate of the tube? If you say that this will work I shall try it with the split-filament circuit.

J. B. DEVLIN

ANSWER: This will work. If you use with this circuit any one of the 1 watt hard amplifier tubes now on the market with a plate potential of 100 to 150 volts, you should be able to transmit at least 5 miles with an average antenna.

* * *

QUESTION: I want to build my own variable condenser of 43 plates, with a capacity of .001 mfd. Please give me a formula for calculating the sizes of the plates and the spacing I should use to get this capacity. I had in mind the idea of making the plates of zinc.

C. SANDERS

ANSWER: Here is the formula for calculating the capacity of a condenser:

$$C = \frac{\text{Area in sq. Cms.} \times (n-1) \text{ plates} \times k}{4 \times 3.1416 \times t \times 900{,}000}$$

Where C = capacity of the condenser in microfarads;
k = (1) for air dielectric
(6) for mica dielectric
and t = thickness of insulation in centimeters.

We suggest that you do not use zinc plates for the condenser, as they will bend and cause the condenser to short circuit. An aluminum sheet of a thickness of 1/32 inch will be satisfactory.

* * *

QUESTION: I am using a single circuit receiver with a WD-11 1½ volt tube working on a dry cell. Will I have to use a storage battery and larger tubes for an amplifier to add to this set or can I use two more WD-11's as amplifiers?

WILLIAM MACKENZIE

ANSWER: You may use the same type of tubes for your amplifier that you are using for your detector. It would be advisable, however, to connect two more dry cells in shunt to the one you are now using. *Do not connect them in series!*

QUESTION: Will it be possible for me to use spiderweb coils with a single circuit regenerative hook-up? If so, will you please give me the best hook-up and the proper number of turns to wind on the coils for wavelengths up to 600 meters?

G. K. HAIST

ANSWER: These coils will work satisfactorily with the circuit shown in the diagram in Figure 1. The primary coil should be wound with 40 turns of wire, with a tap at every tenth turn. This coil should be mounted stationary. The tickler coil should be wound with 60 turns and should be mounted on a hinge so that its position in relation to the primary coil may be varied by swinging, as a door swings on a hinge.

The other parts you will need for this hook-up are:

1 variable condenser, .001 mfd.
1 four-point switch
1 grid condenser, .0005 mfd.
1 grid leak, 1 or 2 megohms
1 telephone condenser, .001 mfd.
1 vacuum tube and socket
1 pair telephone receivers, 3000 ohms
1 filament rheostat, 6 ohms
"A" and "B" batteries

* * *

QUESTION: I want an authoritative opinion upon this puzzling question: A friend, who has a small crystal receiving set, is getting regularly the broadcasting programs from WJZ, KDKA, and also from Ohio stations. They come in clearly, as I have reason to know, as I have listened in with him repeatedly. There are a number of very sensitive, highly developed bulb receivers in his near vicinity, and I tell him that he is getting his long distance signals from the aerials of these stations which are reradiating. To me it is clear that his location near the bulb sets is the explanation while he claims that it is his fine aerial, which is 100 feet long and 40 feet high. We want to know if what he claims is possible with a crystal set. The set has a wooden panel, variometer, variable condenser, a crystal detector and a buzzer test with a dry battery.

DR. CARL E. MEYER

ANSWER: We believe that your friend is receiving long-distance telephone stations direct. If he were hearing them through reradiation from other nearby sensitive receiving sets, the reradiating set would have to be in a state of oscillation and it is not probable that this would be the case because the reradiating station would then *not* be receiving the music clearly but accompanied by a distorting whistle. In the early days of amateur radio when the crystal detector was supreme (the vacuum tube not being in existence) distances up to 2000 miles were bridged by the "crystal."

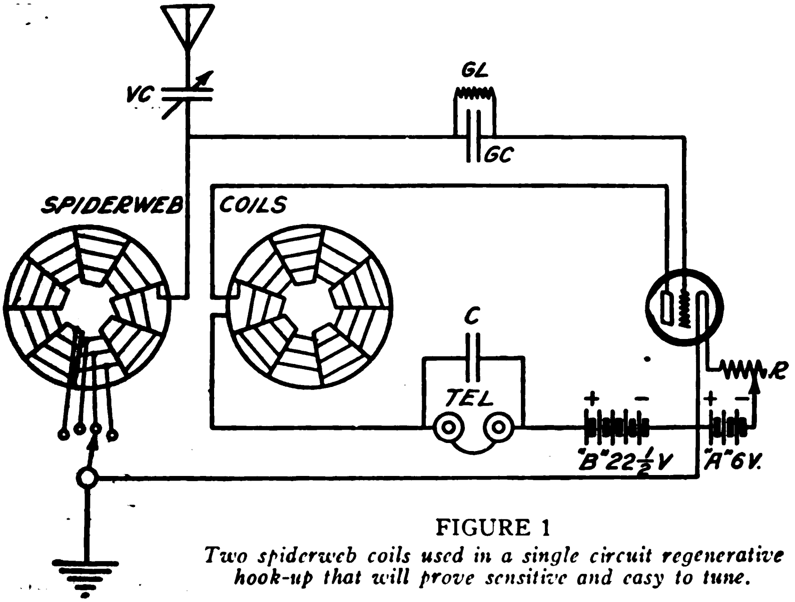


FIGURE 1

Two spiderweb coils used in a single circuit regenerative hook-up that will prove sensitive and easy to tune.

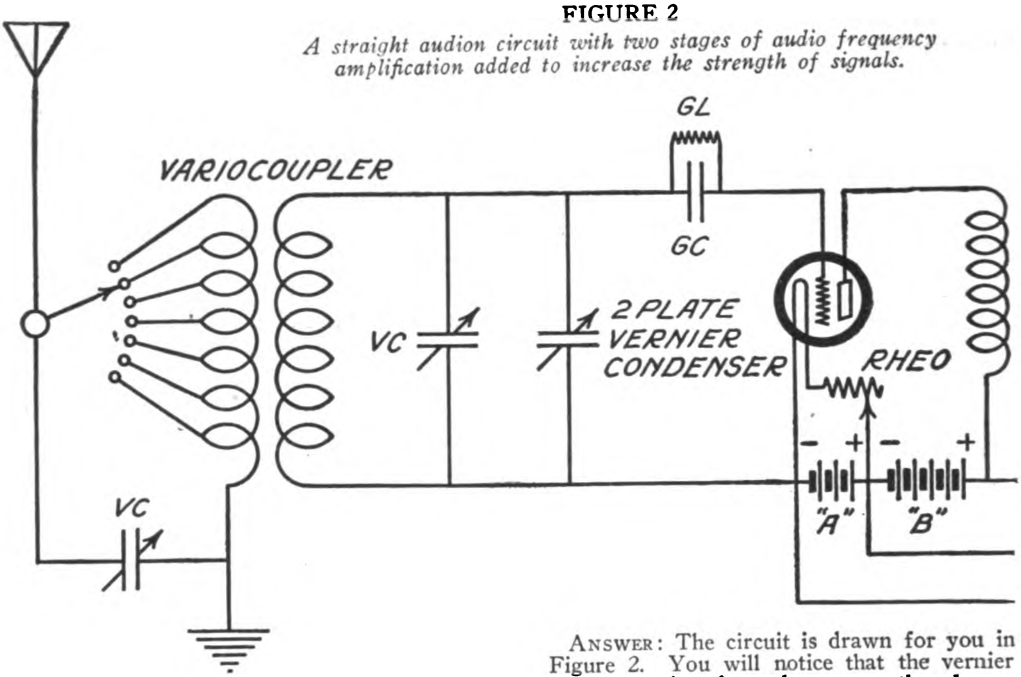


FIGURE 2
A straight audion circuit with two stages of audio frequency amplification added to increase the strength of signals.

QUESTION: I would like to obtain the diagram of a circuit which will give the best results with the following parts:

1—Horne variocoupler
2—variable condensers, .00055 mfd.
1—2-plate vernier condenser
2—amplifier transformers, type A-700
1—detector tube
2—amplifier tubes
3—rheostats
1—grid condenser
"B" batteries

MURRAY K. KITTREDGE

ANSWER: The circuit is drawn for you in Figure 2. You will notice that the vernier condenser is shunted across the larger secondary condenser to help tune the secondary circuit where finer tuning is necessary.

* * *

QUESTION: I have the following parts for a radio receiving set:

1 variocoupler
1 variable condenser
1 grid condenser and leak
1 detector vacuum tube
1 variometer
1 rheostat
"A" and "B" batteries

I would like to make a regenerative set with these instruments. Will you

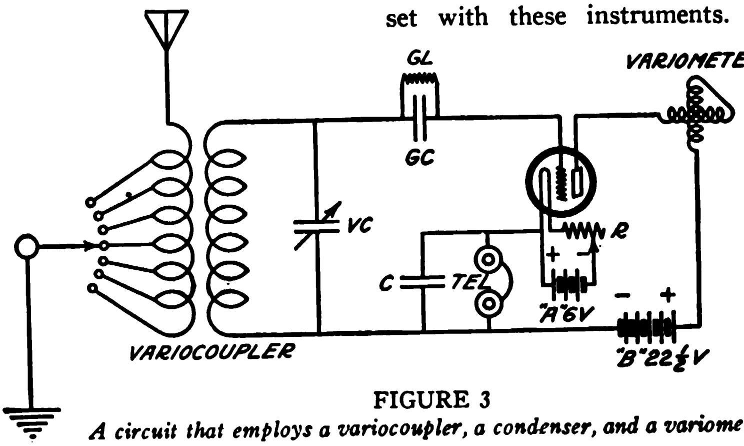
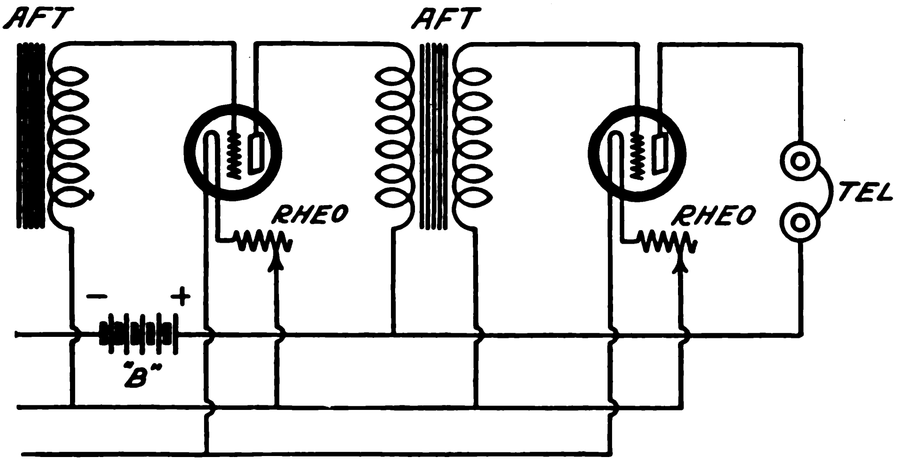


FIGURE 3
A circuit that employs a variocoupler, a condenser, and a variometer.

kindly make me a diagram that will enable me to use them?

E. DEVEREAU



ANSWER: The hook-up shown in Figure 3 will help you. It is sometimes necessary to put a fixed condenser across the telephones in order to get the set to oscillate. This condenser is shown in the diagram as C. The primary circuit is tuned by means of the taps on the variocoupler. The secondary circuit is tuned by the variable condenser, and the regeneration is controlled by means of the variometer. This circuit will tune much sharper than the ordinary single circuit tuner and will be just as simple to construct at home with the ordinary household tools.

QUESTION: Please tell me how to add one stage of amplification to the circuit on page 192 in Mr. Hogan's article in the November issue. I would like to use jacks in each stage.

F. V. KRISTELLER

ANSWER: Consult the hook-up given in Figure 4. This circuit will bring in the distant signals, and will be found simple to tune.

All tuning is done with the taps on the primary coil and with the variable condenser. The regeneration is controlled by rotating the secondary coil, which serves as a tickler. It is advisable when tuning this set not to allow the set to oscillate or it will reradiate and cause interference.

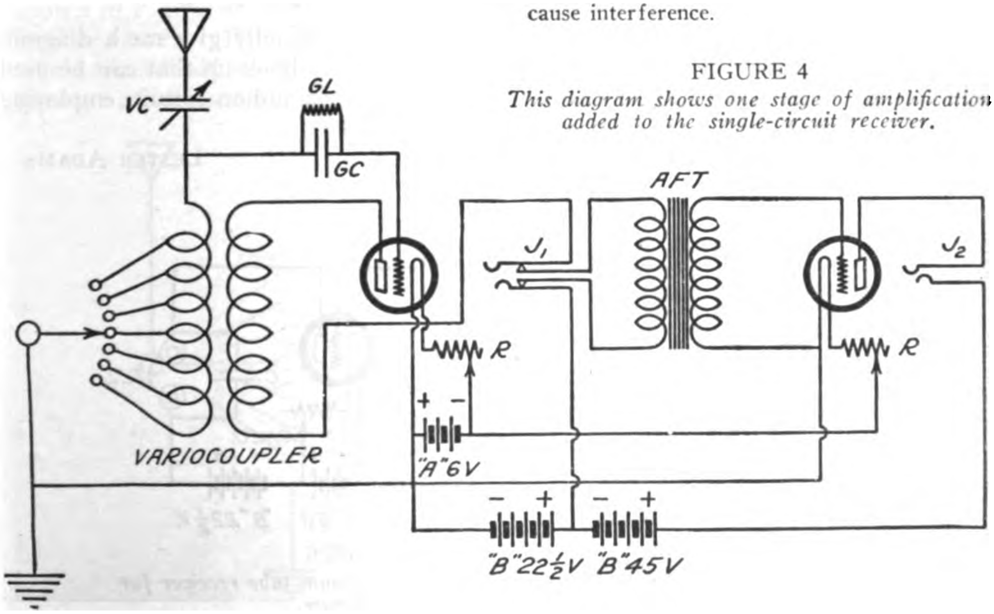
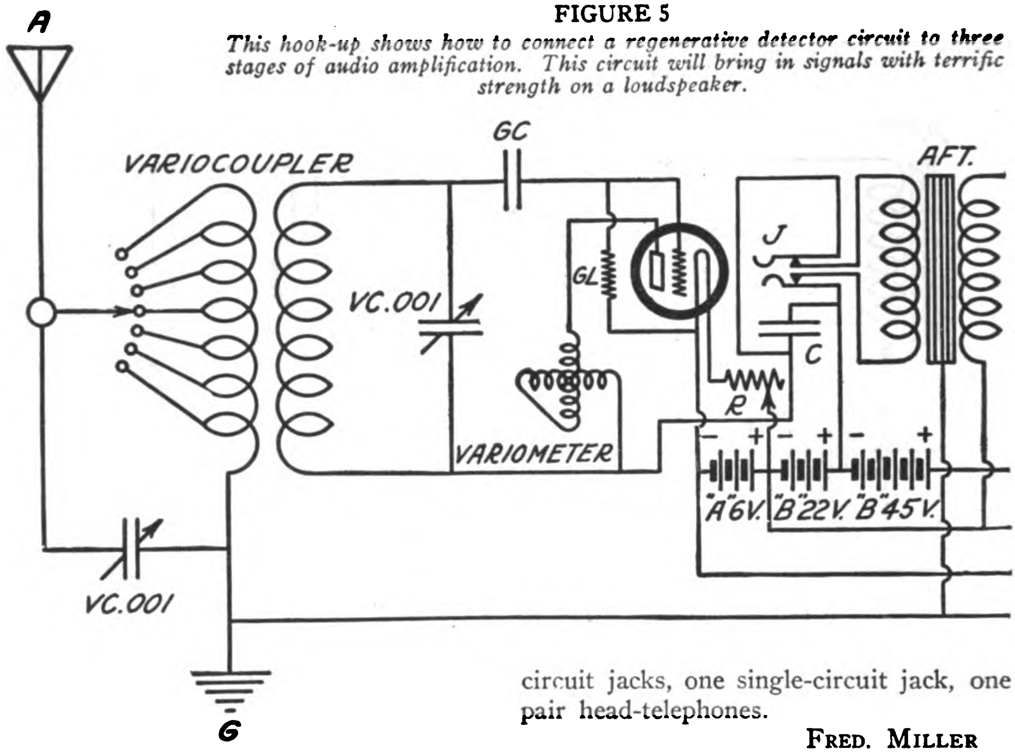


FIGURE 4
This diagram shows one stage of amplification added to the single-circuit receiver.

FIGURE 5

This hook-up shows how to connect a regenerative detector circuit to three stages of audio amplification. This circuit will bring in signals with terrific strength on a loudspeaker.



Question: Please show me how to connect up the following instruments in a regenerative circuit with three stages of audio frequency amplification, with jacks for each stage: One variocoupler, two variable condensers, one grid condenser, one grid leak, one variometer, three amplifying transformers, four rheostats, four vacuum tubes (hard), three double-circuit jacks, one single-circuit jack, one pair head-telephones.

Fred. Miller

Answer: In Figure 5 you will find a diagram that employs the instruments you have on hand. A grid condenser of .0003 to .0005 mfd. capacity should be used with a grid leak of one or two megohms.

* * *

Question: Kindly give me a diagram of the simplest hook-up that can be used with a straight audion circuit, employing a variocoupler.

Lester Adams

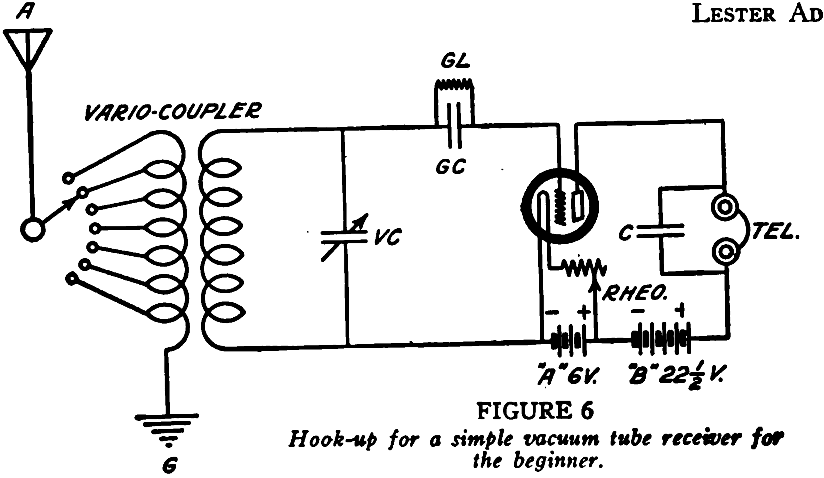
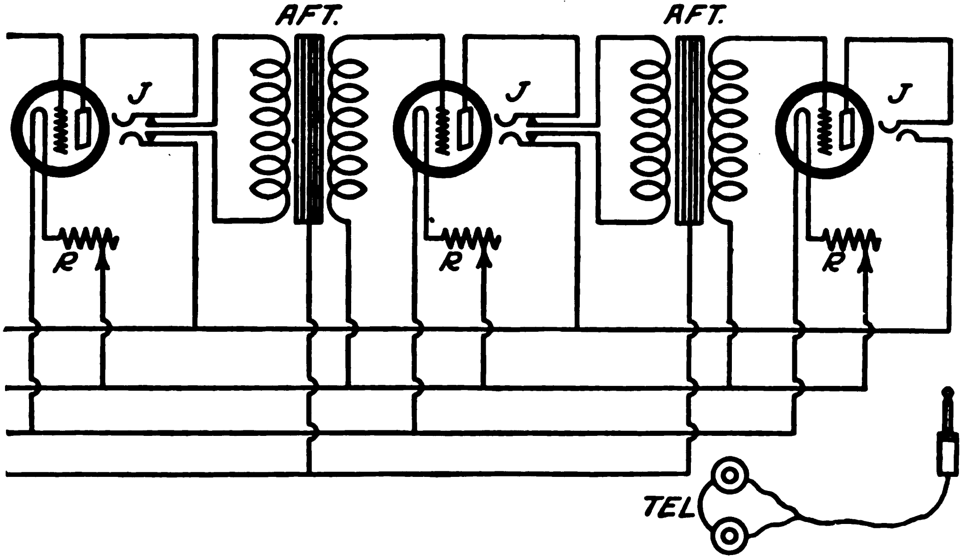


FIGURE 6

Hook-up for a simple vacuum tube receiver for the beginner.

Answer: This hook-up is shown in Figure 6. All tuning is accomplished by means of the tapped primary of the variocoupler and the variable condenser VC. The parts designated as GL and GC are, respectively, a grid leak and a grid condenser. The condenser C is a telephone condenser. This circuit while not regenerative will bring in musical programs clearly and with no difficulty of adjustment. By adding a variometer in the plate circuit it can be made regenerative.



Question: I have a circuit like that shown in Figure 4, page 212, of the November issue of Popular Radio, and I would like to add one stage of audio frequency amplification to it. Will you please draw me a diagram showing how to connect it up?

L. F. Self

Answer: The diagram in Figure 7 gives you the hook-up you require. You will need the following additional apparatus:

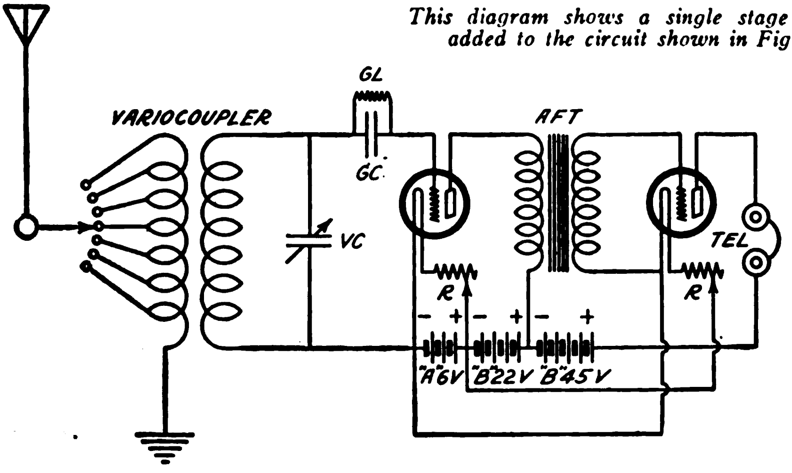
1 audio frequency transformer
1 vacuum tube amplifier and socket
1 filament rheostat
2 "B" batteries, each 22½ volts

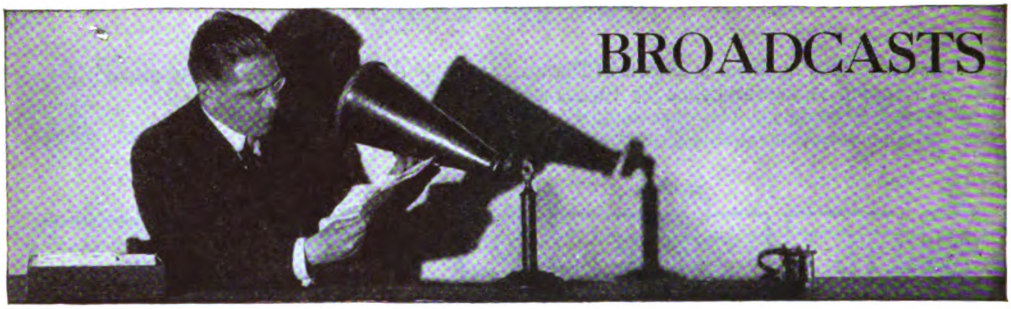
You will find that this addition to your set will greatly increase the volume of the received signals.

However, if you add a second stage of audio frequency amplification you will obtain a signal of still greater volume.

FIGURE 7

This diagram shows a single stage amplifier added to the circuit shown in Figure 6.





ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

A French Amateur Is Picked Up by an American Amateur

THE first American amateur to pick up a radio signal from a French amateur is Gene E. Witham, of New York. On the night of December 26, 1922, he heard station 8AB, operated by Leon Deloy of Nice, France. The American, who is a sixteen-year-old schoolboy used a single-tube detector instrument only.

* * *

$5000 for Broadcasting Copyrighted Songs

THE American Society of Composers, Authors and Publishers has decided to charge fees ranging from $250 to $5,000 to radio stations that broadcast songs and musical selections. The fee will be fixed by the Society, according to the broadcasting station's location.

* * *

Ocean Liners Establish a Radio Letter Service

INAUGURATION of an "ocean letter service" aboard Shipping Board vessels, providing facilities whereby messages from a ship bound in one direction can be transmitted by radio to a ship bound in the opposite direction, and mailed by the receiving ship upon arrival in port, was announced recently by the board officials.

* * *

A Plan to Standardize Radio Sets

YOU will be able to buy a standardized, rated and tested radio set if the conference called in New York by the Bureau of Standards is successful. Representatives from technical organizations and manufacturers interested in radio will discuss methods of standardizing radio receivers in a manner similar to fire extinguishers, automobile tires and other products.

* * *

The First American Amateur to Span the Pacific

THE first signals from an American amateur radio station have crossed the Pacific. A radio operator on board a ship only 120 miles off the coast of China has reported to the American Radio Relay League that he picked up the signals of a member of that organization.

This achievement reinforces the successful trans-Atlantic radio test.

A New Long-Distance Broadcast Record

A NEW long-distance broadcasting record was hung up not long ago by station KDKA of East Pittsburgh, Pa., when one of its concerts was picked up by E. G. Osterhouldt, radio operator on the steamship *J. A. Moffett,* 5,000 miles away, off the coast of Peru.

* * *

A Mail Plane Is Saved by Amateurs

LOST in a fog over Lake Michigan, and with his gas almost exhausted, the pilot of a government mail airplane recently sent out a Q S T (general call) to ask any radio station who heard to telephone the Mayfair landing field and send up rockets. Shortly after, rockets were piercing the fog bank and the lost aeronaut made a safe landing. Six different amateurs had caught the message.

* * *

For the Student Who Forgets to Write Home

FROM Princeton comes the report that the radio club organized among the students has undertaken to transmit to any part of the country, without charge, messages from the undergraduates of the university—an undertaking that is made possible by the cooperation of radio amateurs in relaying messages that they pick out of the ether nightly.

* * *

The Shortest Wave Ever Produced

Radio waves only one-fiftieth inch in length, identical to the longest of heat waves, have been produced at the Nela Research Laboratories in Cleveland, Ohio, by the aid of instruments more sensitive than heretofore available. This phenomena was created by Dr. Ernest Fox Nichols and Dr. J. D. Tear.

The achievement marks the joining of the electric wave and heat wave spectra. In this latest proof of the identical character of light, heat and electric waves, these physicists were successful in using two different types of electric wave receivers to detect and remeasure the long heat waves, about one-third of a millimeter, that were obtained by Rubens and Von Baeyer in 1911 from a quartz mercury arc.

Ordinary radio transmission is by electric waves from 200 meters to 15,000 meters (aboht ten miles) in length. The half-millimeter (or one-fiftieth of an inch) wave produced by Drs. Nichols and Tear are the shortest ever produced.

* * *

Applause Travels 3,000 Miles by Radio

THE destiny of radio as an angel of international peace was given a remarkable demonstration a few weeks ago when the singing of hymns by a chorus in America was picked up by a schoolteacher, J. E. Samuels, in Wales; later in the same (Sunday) evening he picked up other parts of a program, including numbers on the City Symphony concert at the Century Theatre in New York, which was broadcast from station WJZ in collaboration with POPULAR RADIO. Mr. Samuels reported that he clearly heard the applause that followed the numbers on the program.

* * *

What Amateur Can Beat This Record?

COMMUNICATING with thirty-one stations and being heard by ninety-two stations at distances over 100 miles away in a single night is the record of amateur radio station 1CCZ, owned by Edward C. Crossett and operated by W. A. Remy, located at Wianno, Mass. Stations as far away as the Pacific Coast, the Gulf and distant parts of Canada were worked, and every one of the nine radio districts of the country were reached. This is believed to be a record for one night's work.

* * *

The World's Champion Crystal Receiver

A FEW weeks ago Joel Owen, a farmer who lives near Huntsville, Missouri, read the Bureau of Standards' specifications for building a small crystal receiving set—the set that was described in detail in the May, 1922, issue of POPULAR RADIO. He built the set as described at a cost of $14, and surprised himself as much as the radio experts by picking up signals from Schenectady, New York—about a thousand miles away! So far as is known, this is the world's record in broadcast reception for a crystal set, which usually has a range of fifteen or twenty miles only.

* * *

Carols from Christmas Trees

SONG birds in human guise figuratively perched among the branches of the huge Christmas tree erected in Madison Square park, New York, during the holiday week festival. These song birds were selected from among the prominent concert singers, and they actually did their bursting into song from station WJZ. Receiving sets installed in the tree created the impression upon the uninitiated that the singers were actually hidden among the boughs.

* * *

Two Amateurs Send Radio Messages Over 7,000 Miles

ALL records for amateur radio long-distance tests are believed to have been broken when a letter was received December 18, 1922, by the American Radio Relay League from the radio operator of a steamship in the Pacific, announcing that he had received two radio messages, both from amateurs approximately 7,000 miles away.

The league stated that the two messages were sent by William D. Reynolds of Denver and A. C. Hemrick of Aberdeen, Wash.

* * *

Imported Yankee Accent from a Cigar Box

RECEIVING sets made within cigar boxes are of unfailing interest to amateurs. One of the most remarkable reports of the capacities of these miniature receivers comes from Paris; it states that J. L. Luntley, an amateur who lives in the suburbs of Colombes, in the Department of the Seine, picked up on the night of December 25th, 1922, the voice of an American who was talking in Iowa, U. S. A., and that the Yankee accent was distinguishable!

* * *

The Speed of Radio

SOME slight conception of the speed at which radio waves travel (183,500 miles a second) may be derived from the fact that it would take five hours and forty-one minutes for the sound of a cannon to travel, say, from Detroit to Hawaii—assuming that such a great noise could be made. By radio the music of a concert broadcast by WWJ, Detroit *News*, not only could, but recently did reach A. F. Costa, the postmaster at Wailuku, Hawaii, in about one-fiftieth of a second. Wailuku is approximately 4,400 miles from Detroit.

Underwood & Underwood

LISTENING IN ON THE
GALENA PERFECTOS

The education of the radio fan is not really completed until he has built at least one miniature receiving set—preferably in a cigar box. The crystal set shown above was entered in a contest by Ben Davis, of New York.

Amateurs Locate Snowbound Trains

When a tremendous snowstorm swept Wyoming and Colorado early this winter and destroyed wire communication, trains No. 29 and No. 30 of the C. & S. Railroad got stalled somewhere out in the drifts. The dispatcher at Casper could not get Denver; in the emergency he turned to the radio amateurs for help. Through the good work of 7ZO at Casper, 9ANG at Kansas City and AD7 at Fork Crook, Omaha, the dispatcher at Denver was finally reached; the missing trains were then located and help was sent to them.

* * *

316 *American Amateurs Are Heard in Europe*

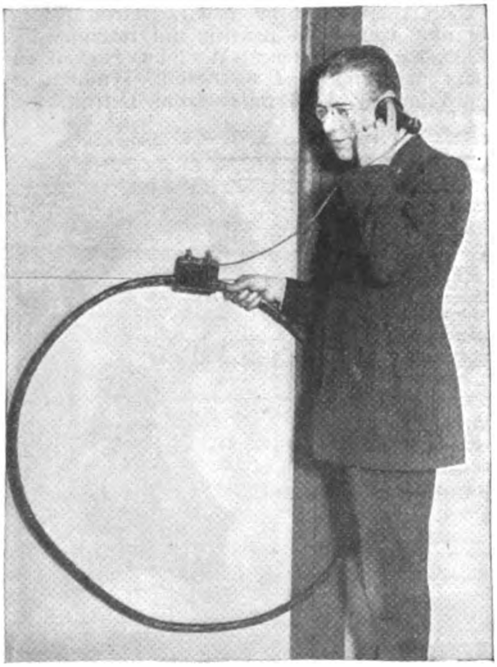
A year ago only thirty-three American amateur stations succeeded in getting across the Atlantic in the test conducted by the American Radio Relay League. Final reports of the recent test show that 316 American stations were heard in Great Britain, France and Switzerland—only six less than the total number of amateur stations that qualified for the final tests.

* * *

Radio Waves Penetrate 125 Feet of Rock

Radio messages were received recently through 125 feet of soil, shale, sandstone and slate by Bureau of Mines officials in the experimental mine operated by the Government near Pittsburgh. The new use of radio is expected to effect a revolution in the methods of rescuing entombed miners.

"We are trying," said James W. Paul of the Bureau, "to find out if communication can be established with miners who are a mile or more under ground, through the covering of rock, usually at least several hundred feet thick. Fire and other accidents easily put a telephone line out of service, but if radio communication can be maintained we will always have a way of reaching men quickly."



© Kadel & Herbert

A FIRST-AID RADIOPHONE

This portable inductive radio set, designed for rescue work in mines, caissons and submarines, requires no ground or aerial, and the entire electrical power is furnished by small dry batteries. The inventor, Bernaye Johnson, reports that he has taken his apparatus 200 feet down into a coal mine and was heard clearly on the surface of the earth.

* * *

The First Amateur Signal to Come from England?

What are believed to be the first radio signals from English amateurs to be picked up by American amateurs have been reported by A. B. Tyril, of Riverhead, New York, and F. Kral, of Washington, D. C. The signal, 2 F2, was transmitted by the Manchester Wireless Society of Manchester, England, on the night of December 22, 1922. The reception of the signals by the two Americans was promptly reported to the American Radio Relay League of Hartford, Conn. It is possible that this is the first recorded instance of an amateur signal to reach this country from across the Atlantic.

* * *

What Radio Is Doing to the Small Church

From its very earliest days Popular Radio has been pointing out how the introduction of radio into the home is destined to have a profound effect upon the church organizations. That effect is now being felt. Authorities of the Episcopal, Methodist and Presbyterian churches are reporting that many of the churches in the small cities and towns are facing ruin, as their former parishioners are now staying at home and are listening to the better sermons and the better music that is being broadcast from the large centers. The result is that the former churchgoers are gradually withdrawing their financial support from the local church.

One Presbyterian church in Trenton recently complained that its people preferred Episcopal service by radio to Presbyterian service in the church; thus sectarian troubles are added to the financial distress of the harassed pastors!

* * *

Running Down Criminals by Radio

Broadcasting information about fugitives, even to the extent of eventually broadcasting their portraits and fingerprints, may become an established feature of our police system if Attorney General Daugherty's plans are carried into effect for the creation of a National Bureau of Identification and Information. William J. Burns, Chief of the Bureau of Investigation, foresees the development of the idea on a world-wide scale.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

The Pending Radio Legislation in Washington

AS this issue of POPULAR RADIO goes to press, the fate of Congressman White's Radio Bill (H.R. 11964) is still pending—with prospects for its passage during the present session of Congress. It was unanimously reported out by the House Committee and was scheduled for early action. If the bill is acted upon favorably in the House, Senator Kellogg will attempt to secure the co-operation of his colleagues in putting this much-needed legislation through before he retires on March 4th.

The bill is of special interest to radio amateurs because of the proposed changes in the wavelengths assigned to them. It strikes from the existing law the words "200 meters," and provides that "the wavelengths for amateurs shall not be less than 150 meters nor more than 275 meters." This change, which was desired by the amateurs, has the approval of the conference and of the committee. The amateur is the only user of radio to whom a definite assignment of wavelengths is made in the law itself; other wavelengths are allocated by the Secretary of Commerce. The committee apparently recognizes the value of the service which the amateur is rendering in the development of the radio art and in the training of skilful operators, and feels justified in continuing this special recognition, which is given to them.

While little opposition to this bill is anticipated, nevertheless much helpful legislation has been lost in the past because of lack of public interest and insistence.

If the radio operators and fans want the White Bill passed this session, they must indicate their desires to their representatives in Congress.

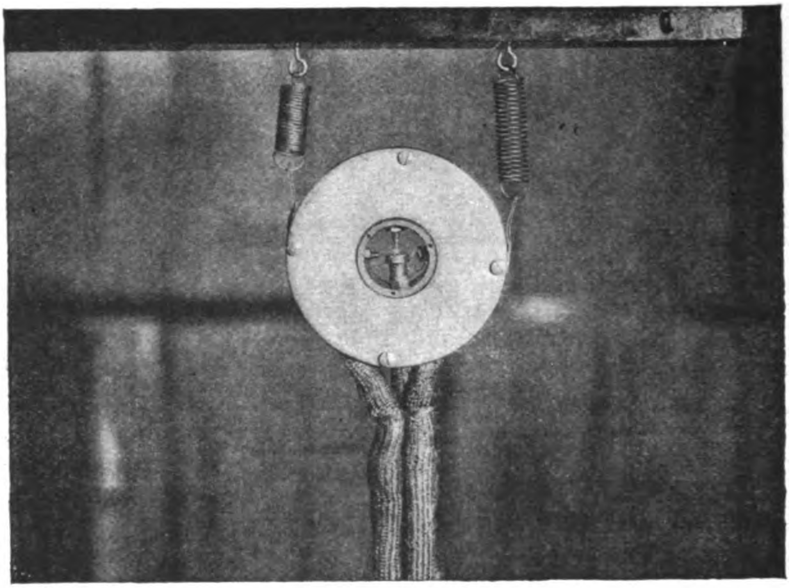
If you have not yet acted upon this suggestion, do so today. Send your Congressman and your Senator at Washington this message:

"I favor the radio bill H.R. 11964."

If the bill is not passed this session, new measures will have to be introduced in the next session of Congress, which does not organize until this coming December.

It may be gratifying to the readers of POPULAR RADIO to learn that their active support of this magazine's efforts to get action on this bill and their response to its appeal to write to their representatives in Washington (as urged in the January number) has brought gratifying results, and that POPULAR RADIO's bound volume of letters from the foremost radio scientists, manufacturers and dealers, which Paul Godley brought to the Capitol, was a prominent and important feature of the hearings.

A further report of the progress of this bill will be furnished by Paul Godley in the next issue of this magazine.



Westinghouse

A MICROPHONE BUILT ON AN ENTIRELY NEW SCIENTIFIC PRINCIPLE

This unique device literally "catches sound with an electric spark." A high voltage glow discharge takes place continuously between the upper electrode (in the inner circle) and the lower shielded electrode. The bright portion of the discharge is covered by a cylindrical shield and only the dark portion, known as the "Faraday space," is exposed to the sound waves to be recorded. As these waves pass through this space they control the amount of current flowing in the discharge, and thus modulate the current in perfect conformation with these waves.

The Remarkable New "Glow Discharge" Transmitter

WHAT is regarded by radio experts as the most efficient transmitter thus far developed is announced for the first time in POPULAR RADIO by courtesy of the Westinghouse company, in whose research laboratory in Pittsburgh, Dr. Phillip Thomas, the inventor, has been conducting his experiments. The effect of this new transmitter upon broadcasting and the significance of its departure from the scientific principles on which transmitters have heretofore been based is described briefly in the following report of the Technical Editor; a more extended notice of the device will appear in a later issue:

Even in the best microphones heretofore developed some of the richness and color of the musical tones has been lost. The trouble has lain in the diaphragm—a little disc of metal which is supposed to vibrate when sounds are impressed against its surface. It is practically impossible to construct a diaphragm which will respond to extremely low tones and high tones at the same time; every vibrating object has a natural period of vibration and responds to impulses of this frequency to the exclusion of vibrations which differ to any extent from it.

Dr. Thomas has rejected the diaphragm as a pick-up device on account of this inherent incapacity to reproduce intricate sound values. After many months of research he has evolved a new device, known as "the glow discharge" transmitter. This new device has no natural period and reproduces tones running from a frequency of 60 to 6000 with absolute truthfulness. Any combination of these frequencies, such as employed in musical instruments, are recorded with naturalness and purity.

During continuous tests at KDKA Pittsburgh, the new transmitter has demonstrated its worth and capacity. The principle of the transmitter is that of the impression of the sound waves on a high-potential low-current discharge between two electrodes, which changes the resistance of the arc column and so controls the electric modulator current.

The development of this device is a forward step in obtaining better broadcasting, as the music transmitted by a station using the device will be true to life and colorful.

LAURENCE M. COCKADAY

NEW PRICES ON
"WORKRITE"

Prices on the WorkRite Super 180° Variocoupler and the WorkRite Super Variometer have been reduced from $6.00 last spring to $3.50 now. That is a big reduction and it has brought us in so many orders that we are rushed to fill them. You want WorkRite Radio Parts on your set. In order to get prompt delivery we suggest that you send in your order at once.

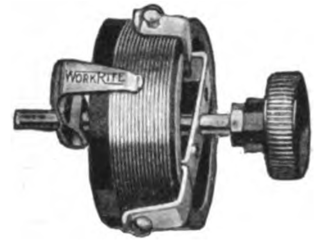
Remember that these instruments are of the high WorkRite Quality. Compare the prices with those on unknown inferior instruments and then you will not hesitate to order your WorkRite parts right away.

WORKRITE SUPER 180° VARIOCOUPLER

WorkRite Super 180° Variocoupler, each,
WorkRite Super Variometer, each, $3.50

WORKRITE SUPER VERNIER RHEOSTAT

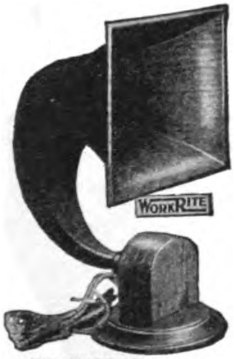
Here is a Real Rheostat! Indispensable on the detector tube when working long distance concerts. For quick adjustment the knob is pushed in and out, causing the contact arm to slide across the resistance wire. For fine adjustment the knob is turned around and the contact arm feeds along the wire.



Patent Applied For

Our special resistance wire is non-corrosive and does not change in resistance through change in temperature. POSITIVELY NEVER GETS HOT. The WorkRite Super Vernier Rheostat is really remarkable in its performance and no detector tube should be without one. To appreciate it you should try one.
Price **$1.50**

WORKRITE CONCERTOLAS



CONCERTOLA JR.

These Loud Speakers are becoming more popular every day. And no wonder when you consider that they have no metal except in the phone units and therefore do away with that "tin-panny" tone entirely.

Both the Concertola Senior and Junior are mahogany finish and will harmonize with the furnishings of your home.

THREE-DAY TRIAL! If after you have tried the Concertola on your set you find that it does not mork satisfactorily return it and we will refund your money.

These instruments are intended for use on vacuum tube sets having two stage amplification.

WorkRite Concertola Jr. with Cord and Phone Unit, $12.00
WorkRite Concertola Jr. with Cord and Phone Unit, $24.00

WORKRITE RADIO PARTS WORKRITE

THE WORKRITE MANUFACTURING CO.

5547 Euclid Ave. **(Branch Offices, 2204 Michigan Ave., Chicago)** **Cleveland, Ohio**

The Leading Radio

Acme Apparatus Co.
A-C Electric Co.
Adams Morgan Co.
Amateur Radio Supply Co.
American Radio & Research Co.
Andrea, Frank A. D.

Benwood Company
Beamish Elect. Co.
Boston Scale & Machine Co.
Bowman Co., A. W.
Briggs & Stratton
Bristol Co.

Canadian Machine Telephone Co.
Capitol Phonolier Corp.
Chelsea Radio Co.
Chicago Radio Apparatus Co.
Cino Radio Co.
Clapp-Eastham Co.
Cleartone Radio Co.
Cleveland Radio Mfg. Co.
Cleveland Radio Laboratories
Cleveland Products Co.
Consolidated Radio Call Book Co.
Connecticut Telephone & Elect. Co.
Corwin Co., A. H.
Crosley Mfg. Co.
Central Station Equipment Co.

DeLancey, Felch & Co.
Doron Bros. Elect. Co.
Dryfuss Co., P. M.
Duck Co., Wm. B.

Echo Radio Company
Electric Machine Corp.
Experimenters Information Service Co.

Fargo Radio Service Co.
Fast Feed Drill & Tool Co.
Federal Institute of Radio Telegraphy
Federal Telegraph Co.
Federal Telephone & Telg. Co.
Freed-Eiseman Co.

Galvin Electric Co.
General Apparatus Co.
Great Eastern Radio Corp.

Halliwell Electric Co.
Hartman Electric Co.
Heslar Radio Co.
Hyman & Co., Henry
Ingersoll Radio Shops

Kennedy Co., Colin B.
Klaus Radio Co.
Kilborne & Clark

Laurence Radio Electric Co.

Magnavox Co.
Marshall-Gerken Co.
Manhattan Elect. Supply Co.
McCorkel Mfg. Co.
Meteor Radio Laboratories
Michigan Radio Co.
Midwest Radio Co.
Missouri Radio Co.
Moon Radio Corp.
Mutual Purchase Assn. (Standard Radio Co.)

National Radio Institute
Nairsand Radio Mfg. Co.
New York Coil Co.

Paramount Radio Corp.
Premier Radio Mfg. Co.
Precision Machine Co.
Precision Equipment Co.

Radio Apparatus Co.
Radio Amusement Co.
Radio Service & Mfg. Co.
Radio Shop of Newark
Radio Distributing Co. (Radisco)
Radio Products Co.
Radio Electric Company
Radio Shop of California
Radio Instrument Co.
Radio & Scientific Apparatus Co.
Raymond Radio Corp.
Ray Mfg. Co., J. A.
R. T. Radio Corp.
Reynolds Radio Co.

Scientific Engineering Co.
Signal Electric Co.
Simplicity Mfg. Co.
Simplex Radio Co.
Ship Owners Radio Service Co.
Smith & Smith
Stanley & Patterson
States Radio Corp.
Stern & Co.
Sleeper Radio Corp.

Telephone Maintenance Co.
Tresco
Tuska, C. D.

Waveland Radio Co.
Western Electric Co.
Western Radio Co.
Winckler, Frederick
Wireless Shop, The
Wireless Mfg. Co.

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

Manufacturers use *and* like

FORMICA

The radio engineers of the leading radio manufacturers all over the United States have approved Formica in the most sincere and convincing way—by adopting it and using it in their production of radio equipment.

No other insulating material for panels, tubes, and other parts can show a list of makers of high-grade radio equipment using their material that is comparable to that printed on the page opposite. It is practically a directory of independent radio manufacturers in the United States.

This overwhelming preference for Formica among the men who, among all others, know most intimately the qualities and characteristics of radio insulation means only one thing.

IT MEANS THAT FOR YEARS FORMICA HAS MAINTAINED A QUALITY AND UNIFORMITY THAT IS NOT TO BE HAD ELSEWHERE.

These men like the handsome Formica finish. They like the way it works with ordinary tools. They like its high dielectric strength and the wonderful uniformity of the product. They like the fact that it improves with age instead of deteriorating.

The trained engineers and purchasing agents of these manufacturers can scarcely be mistaken in their judgment of materials. The amateur is perfectly safe in following their lead.

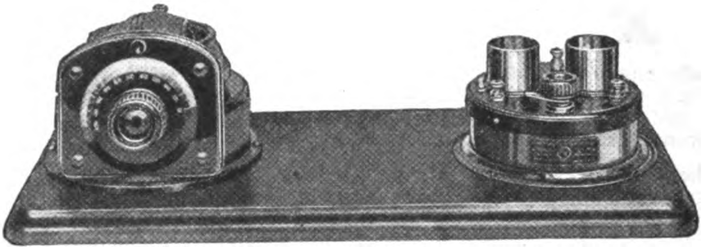
> *DEALERS: Formica advertising and sales support is the most aggressive and effective in the industry. The Formica Insulation Company treats you right.*

THE FORMICA INSULATION COMPANY
4641 SPRING GROVE AVENUE, CINCINNATI, O.

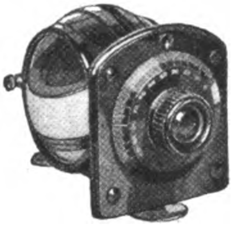
FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

ATWATER KENT

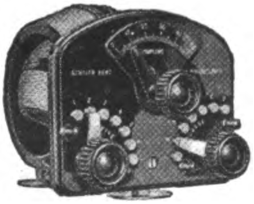
Receiving Sets and Parts



Complete Receiving Set—Coupled Circuit Tuner and Detector 1-stage
A similar set includes Detector 2-stage Unit



Mounted Variometer

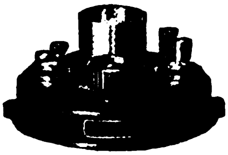


Mounted Variocoupler

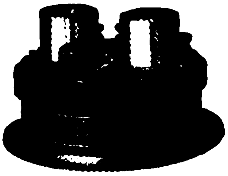
YOU'LL buy ATWATER KENT Radio Equipment on appearance; but you'll keep it for the quality of its performance.

You can buy complete sets in several different combinations, or you can start, if you wish, with a single tube set and add to it as you go along.

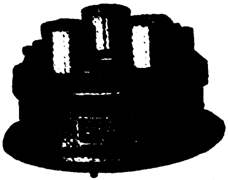
If you prefer to build your own set, the line includes sockets, trans-



Detector Unit



Detector 1-stage Amplifier

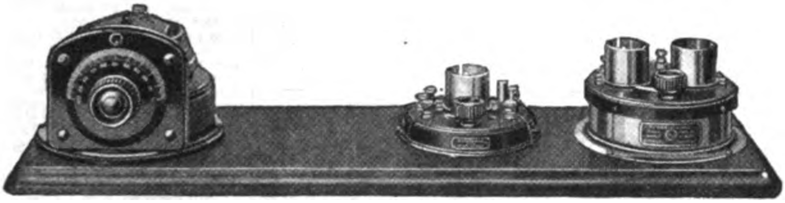


Detector 2-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY
4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

ATWATER KENT

Receiving Sets and Parts



Complete Receiving Set—Coupled Circuit Tuner, Detector, and 2-stage Amplifier
A similar set is furnished without the Amplifier Unit

formers, rheostats, etc., every unit of which is made with the same particular care that characterizes all Atwater Kent products.

The Detector and Amplifier units are complete including all necessary grid leak condensers, 'phone condensers, transformers and rheostats.

Hear an Atwater Kent set at your dealer's.

Type L Transformer

Condensite Dial

Standard Audion Socket

1½-Volt Tube Socket

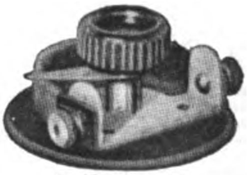


Table Rheostat

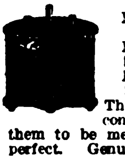
Atwater Kent Manufacturing Company
4933 Stenton Ave. *Radio Dept.* Philadelphia, Pa.

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

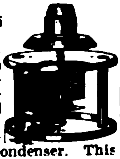
BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS



H812—43 plate .001 Mfd. $2.29
H813—21 plate .0005 Mfd. 1.80
H814—11 plate .00025 Mfd. 1.32
H815—3 plate Vernier 1.05

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

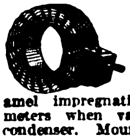
COMBINATION VERNIER VARIABLE CONDENSERS



H824—23 plate .0005 Mfd.
Price $3.25
H826—43 plate .001 Mfd.
Price $3.95

The latest improvement in condensers consists of regular variablecondenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning High-grade design and construction. Finely finished. Suitable for panel mounting.

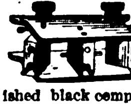
INDUCTANCE "HONEY COMB" COILS



Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd
25	120- 250	H301	$0.39	H320	$0.97
35	175- 450	H302	.42	H322	1.00
50	240- 720	H303	.49	H323	1.07
75	390- 910	H304	.54	H324	1.12
100	500- 1450	H305	.58	H325	1.16
150	600- 2000	H306	.63	H326	1.21
200	900- 2500	H307	.72	H327	1.30
250	1200- 3500	H308	.78	H328	1.36
300	1500- 4500	H309	.82	H329	1.40
400	2000- 5000	H310	.97	H330	1.55
500	2800- 6100	H311	1.12	H331	1.70
600	4000-10000	H312	1.27	H332	1.85
750	5000-12000	H313	1.43	H333	2.00
1000	7900-15000	H314	1.70	H334	2.38
1250	9750-19500	H315	1.92	H335	2.60
1500	14500-26500	H316	2.18	H336	2.76

COIL MOUNTINGS



H340 Three coil mounting $3.59
H341 Two coil mounting $2.69

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil

GALENA DETECTOR

Easy fine adjustment Crystal mounted in cup Moulded base and Knob Brass parts polished nickel finish. **H732** Each..................86c

This Guarantee Protects You
Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

H105 Detector. Each....$4.45
H110 Amplifier. Each.... 5.95
H115 5 Watt Transmitter 7.70

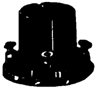
MYERS TUBES

H113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillate anywhere from 2 to 300 volts on plate Each $5.00
H116 Receptacle for above. Each... 1.00
H117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

MYERS CHOKE COIL

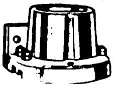
H119 Each $3.50

VACUUM TUBE SOCKETS



Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections Right angled contact springs
H140 Each............39c

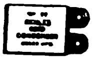
PORCELAIN BASE AND TUBE



H144 Crosley for either panel or table mounting 36c

High Grade combination type for panel or table mounting Metal tube. Highly insulated base.
H146 Each................45c

GRID CONDENSER

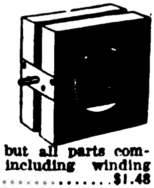


H162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF.........14c
H163 Same as 162 but higher grade. Enclosed in metal case......39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
H160 Each..........18c

VARIOMETER



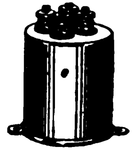
H410—Completely assembled, price $2.69
Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings. positive contacts Highest efficiency.
H411—Not assembled but all parts complete, except wire, including winding form $1.48

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

H415 Price, completely assembled $2.45
H416 Not assembled, but all parts complete. Price, except wire $1.18
H417 Rotor ball only. Each........29c

RADIO FREQUENCY AMPLIFYING TRANSFORMER



H995 Each.........$2.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

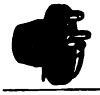
OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling. due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

H234 10 to 1 Mounted. Each......$3.48
H235 10 to 1 Unmounted. Each.... 2.95
H236 3 to 1 Mounted. Each...... 3.40
H237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
H130 Each..............54c

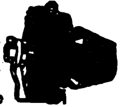


Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
H132 Each..............48c

POTENTIOMETER

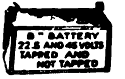
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 146 ohms.
H133 Each 98c

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
H135 Each............78c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

H180 Signal Corps type, small size, 15 cells. 22½ volts. Each, 95c.
H182 Large Navy size, 6½x4x3, 15 cells. 22½ volts. Each.................$1.75
H184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each..............$1.80
H186 Double Navy size 6½x4x6, 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40
H188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
H240—100 ft. coil 45c
H242—500 ft. coil $2.15

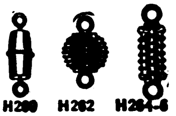
Solid Bare Copper Wire, size 12
H244—100 ft. coil 61c
H246—500 ft. coil $2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

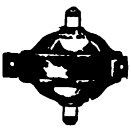
H248—100 ft. coil 65c
H249—500 ft. coil $2.95

ANTENNA INSULATORS



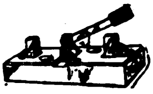
H260 Size 1x3¼. Two for.......17c
H262 Size 2⅛x3¼. Two for.......58c
H264 Size 1½x4. Two for.......80c
H266 Size 1½x10½. Two for $1.35

OUTDOOR LIGHTNING ARRESTER



H900 Price........$1.68
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

H385 Single Pole Single Throw. Each 20c
H387 Single Pole Double Throw. Each 32c
H384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

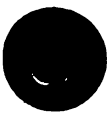
Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

H380—1" Radius
H381—1¼" Radius
H382—1½" Radius
Each 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
H386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB



Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

H900 2¼" Diam. for 3-16" shaft. Ea..19c
H901 2¼" Diam for ¼" shaft. Ea....19c
H904 3" Diam for 3-16" shaft. Ea.....25c
H905 3" Diam for ¼" shaft. Ea....25c
H906 4" Diam. for 3-16" shaft. Ea....42c
H907 4" Diam for ¼" shaft. Ea......42c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks, improved design. Best materials Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only:
H390 Open circuit. Each.....43c
H391 Closed circuit. Each....49c
H392 Two circuit. Each......60c
H393 Single-cir. fila. control..69c
H394 Two cir. fila. control....85c

H395 Plug. Large space with set screws for attaching cord. Each............54c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.

H387 Open Circuit Jack. Each......27c
H388 Two Circuit Jack. Each......35c
H389 Standard Plug. Each.........35c

BINDING POSTS

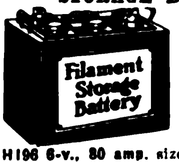
H370-2

Brass, polished nickel finish. Washer and 6-32". screw extending ⅝".... H370 Large size—barrel and knob ¾" long. dozen ....85c H372 Smaller size—barrel and knob 9-16" long. dozen 70c

H376-8

H374 Large size with composition knob. dozen 60c
H376 Large size with hole for phone tip or wire, dozen..............80c
H378 Small size with hole for phone tip or wire, dozen..............38c

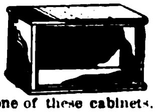
STORAGE BATTERY



A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.

H194 6-v., 40 amp. size. Each..$10.00
H196 6-v., 80 amp. size. Each....$12.50

CABINETS



Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	H420	$2.48
6x10½"	5½"	10"	7"	H422	2.75
6x14"	5½"	13½"	7"	H424	3.30
7x14"	6½"	13½"	7"	H423	3.60
7x18"	6½"	17½"	7"	H426	3.90
7x21"	5½"	20½"	7"	H425	4.20
9x14"	8½"	13½"	10"	H428	3.70
12x14"	11½"	13½"	10"	H430	4.40
12x21"	11½"	20½"	10"	H432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

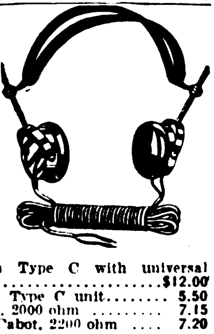
Panel	⅛" thick		3-16" thick		¼" thick	
Size Inches	Art. No.	Price	Art. No.	Price	Art. No.	Price
6x 7	H450	$0.50	H460	$0.75	H470	$0.98
6x10½	H451	.75	H461	1.18	H470	1.47
6x14	H452	1.05	H462	1.55	H472	2.05
7x14	H458	1.20	H468	2.60	H478	2.40
7x18	H453	1.55	H463	2.30	H473	3.10
7x21	H457	1.78	H467	2.65	H477	3.60
9x14	H454	1.60	H464	2.39	H474	3.10
12x14	H455	2.10	H465	3.10	H475	4.15
12x21	H456	3.15	H466	4.65	H476	6.20

BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. **Prices are Transportation Paid.**

H201 For 6 volt battery..........$13.95

BARAWIK QUALITY HEADSETS



These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

H770—2000 ohm.....$4.00

OTHER STANDARD BRAND HEADSETS

H751	Murdock 56, 2000 ohm	$4.45
H752	Murdock 56, 3000 ohm	4.95
H764	Frost, 2000 ohm	4.20
H766	Frost, 3000 ohm	4.95
H756	Red Head, 3000 ohm	5.85
H758	Western Electric, 2200 ohm	9.50
H754	Baldwin Type C with universal jack plug	$12.00
H755	Baldwin Type C unit	5.50
H768	Brandes, 2000 ohm	7.15
H789	Holzer-Cabot, 2200 ohm	7.20

THE BARAWIK CO. 102 S. CANAL STREET **CHICAGO, ILL.**

Kellogg Radio Equipment for Better Results

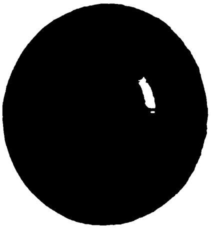
Use, Is the Test

HEAD SETS

The value of extremely light and very small head sets in Radio receiving is most evident when using Kellogg head receivers, which, however, have proved as sensitive and thoroughly efficient as they are light in weight and small in size. The band, too, is especially adaptable and the simple receiver holders, which are held in place on the lower part of the head band by the spring tension of the metal, can be instantly adjusted so as to place the receivers over the ears for the best hearing.

No. 69A Head Set, 2400 ohms, each	$10.00
No. 69C Head Set, 2000 ohms, each	8.00
No. 74A Head Set (single), 1000 ohms, each	5.00

DIALS



All Bakelite. Non-warping, reinforced construction. 5-16 inch shaft with bushings for 1-4 and 3-16 inch shafts included.

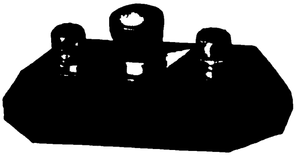
No. 501 3 inch Dial	$1.00
No. 502 4 inch Dial	1.25

Kellogg Radio jacks, plugs, condensers, variometers, tube sockets, dials, insulators, coils, variocouplers, microphones, etc., are the best that money can buy.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, CHICAGO

FRESHMAN PRODUCTS—ACCURATE AND DEPENDABLE

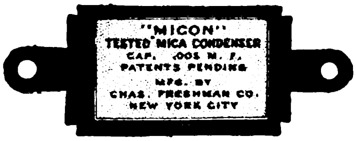
VARIABLE RESISTANCE LEAK



With .00025 mfd. MICON Condenser Combined **$1** Without Condenser **75c**

Unbroken range—Zero to 5 Megohms—Clarifies signals, lowers filament current, increases battery life, eliminates hissing.

"MICON" Tested Mica CONDENSERS



Size	Price
.00025	$0.35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.006	1.00
.01	1.50

Assure absolute noiselessness—clarity of tone—accuracy—constant fixed capacity.

.006 Micons with Variable Resistance Leaks, especially adapted for New Flewelling Super Circuit.

ANTENELLA

No antenna or aerial needed. Eliminates all the inconveniences in radio, operates from any light socket. Price only $2.00.

$2

CHAS. FRESHMAN CO., Inc.
97 BEEKMAN STREET NEW YORK

At your dealer's—otherwise send purchase price and you will be supplied postpaid.

Exide

BATTERIES

For uniform filament current

To meet the requirements of radio service, the Exide Radio Battery was specially designed for the maintenance of a uniform voltage during a long period of discharge. You will take great satisfaction in a battery whose voltage does not drop quickly to a point where frequent adjustment of the apparatus is necessary.

Plates, separators, jars, terminals, every part and each detail of this battery is the result of the experience of the makers of Exide in building batteries for every purpose since the beginning of the storage battery industry.

Exide batteries are used by governments and great industries all over the world. They propel mine locomotives and submerged submarines; they operate the fire alarm system and send your voice over the Bell telephone. Most of the government and Radio Corporation wireless plants are equipped with Exide Batteries.

You can get Exide Radio Batteries at every place where radio equipment is sold and also at all Exide Service Stations.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia

Oldest and largest manufacturers in the world of storage batteries for every purpose

$40.00

CHELSEA REGENERATIVE RECEIVER

A Real Broadcast Receiver

Range 150 to 800 meters

¶ Perfection in design

¶ Pleasing appearance

¶ Simple and accurate tuning

A Chelsea product, embodying Chelsea equipment throughout. Licensed under Armstrong U. S. Pat. No. 1113149. For amateur use only.

Write for our new No. 7 Catalogue

CHELSEA RADIO COMPANY

179 Spruce Street **Chelsea, Mass.**

THE ACOUSTICAL AMPLIFIER

BEL-CANTO

TRADE-MARK

Endorsed by PADEREWSKI

The Magic of the Living Voice

Clear, resonant, mellow-toned as an old violin, the BEL-CANTO AMPLIFIER gives in its original richness the living voice of the artist, or the most delicate tones of an orchestra. Designed on the principle of the human throat, and built of reeds and metals that will not vibrate, it entirely eliminates all harshness and sound distortion, amplifying to unparalleled perfection.

Read what the World's Most Famous Pianist says of BEL-CANTO:

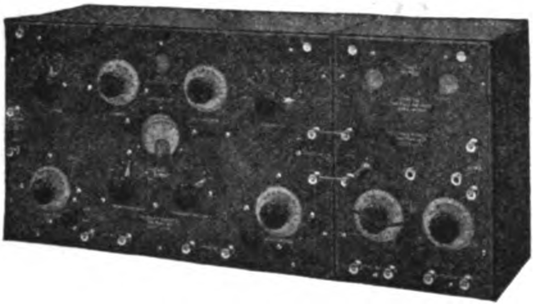
> It was with great pleasure that I heard your Bel Canto loud speaker, the other day. The clarity and volume of tone transmitted, and particularly the absence of sound distortion make it a remarkable device.
>
> Truly yours,
>
> I. J. Paderewski

Special extra sensitive phone unit, ample cord and plug. Price $30.00 F. O. B. New York. At your dealer or direct from maker.

BEL-CANTO is adjusted for the following circuits: Regenerative two stages of amplification for stations within 50 miles. For long distance reception 5-tube radio and audio frequency circuit.

BEL-CANTO CORPORATION

417 East 34th Street **New York City**



KENNEDY
Broadcast Receivers

THE PUBLIC is becoming educated to the fact that there are various grades of radio sets, just as there are various grades of phonographs, automobiles and other merchandise.

If you are a discriminating buyer; if you take "pride in ownership," in possessing things better than ordinary—having in your home things of which you can be justly proud, you will be interested in Kennedy Equipment.

If you could view the Kennedy Receivers through the eyes of the Engineer or Scientist, you would understand why it is possible to *eliminate interference* and obtain *long-distance reception* so readily with them.

Kennedy Equipment is made in various types, ranging in price from $90.00 to $370.00. May we send you full particulars?

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

KENNEDY

Built on Honor

The Acid Test

Gently tap one terminal of Ambassador Phones on a cent, or your tongue, and a faint "click" will be heard.

(Other phones will not stand this test.)

Type A B	Prices
2000 Ohms	$5.00
3000 Ohms	5.50
4000 Ohms	7.00
5000 Ohms	8.00

Individuals may order by mail and we will gladly ship C. O. D.

Ambassador
RADIO-PHONES
The PHONES THAT STAND THE ACID TEST
Finest in the World at the Price

$1000 REWARD

to anyone showing proof of our refusing to stand back of our guarantee on Ambassador Phones.

Specifications

Adjustable (navy type) headbands, comfortable and strong, beautifully nickeled.

Case of heavy stamped aluminum.

Cap of finest hard rubber and unbreakable.

Coils wound with highest grade enameled copper wire.

Magnets of Chrome steel will retain their power for years. 5 foot cords—best grade tinsel.

Weight, 12 ounces. Shipping Weight, 1 lb.

Our Guarantee

If you are in any way dissatisfied with our product, return same within thirty days and your money will be refunded on request

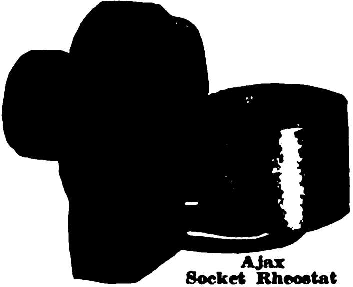
Special Discounts to Dealers

TOWER MANUFACTURING CO. - 114 Station St., Brookline, Mass.

Phono-Phane Permanent Radio Detector

The only fixed radio detector requiring no adjustment. Used in place of crystal or vacuum tube detector. Gives excellent quality of sound without distortion. Detects telegraph signals at several thousand miles. Detects broadcasted music more clearly than vacuum tube detector, and requires no amplification where the incoming signal has sufficient strength to actuate the sensitive phones.

Handsome, substantial, suitable for assembly in the finest radio equipment. Guaranteed against imperfection or faulty operation. List, each.. **$3.50**



Ajax Socket Rheostat

A device for which amateurs and professionals have long been waiting. Eliminates wiring between socket and rheostat. List each **$2.00**

Pruden Reliable Radio Specialties

FOR GOOD RESULTS!

THE name "Pruden" back of standard Radio Equipment is a guarantee of mechanical excellence, perfection of workmanship and scientific correctness of design.

Now, more than ever, when the market is flooded with inferior goods, it pays to buy standard trade marked products.

You can pin your faith to "Pruden." Money-back unconditionally if you do not get complete satisfaction.

Just a few leaders of Pruden Reliable Products shown here that will give you better radio results at no greater cost.

Everything sent F. O. B. Jersey City. Send money by registered mail, post office or express money order.

Dealers write today for our interesting proposition

FREDERICK H. PRUDEN Inc.
999-P Bergen Ave. Jersey City, N. J.

YOU'LL get far more enjoyment from the Radio with a Music Master. And you can invite your friends to share that enjoyment and be sure of perfect results. Let your dealer demonstrate MUSIC MASTER to you today! It will amaze and delight you!

14 in. aperture (Home model) .	$30
21 in. (Concert, Dancing, etc.) .	**$35**

Complete ready to attach in place of headphones. No tubes or batteries required.

JOBBERS DEALERS **A MUSIC MASTER will be sent to members of trade with full privilege of return. Complete details and trade prices on request.**

GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

CHICAGO **PHILADELPHIA** *624-628 Market St.* **PITTSBURGH**

Geraco Phonograph Attachment converts your Victrola or Columbia into an efficient loud-speaker.

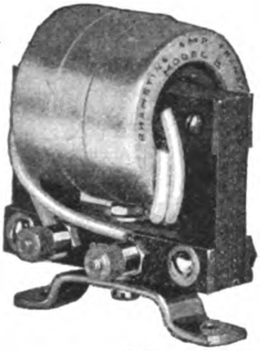
Complete . . **$10**

GERACO
PROVEN RADIO PRODUCTS

Radio apparatus and parts bearing the GERACO trade mark are thoroughly tested and guaranteed. Write for descriptive literature.

RHAMSTINE*

Amplifying Transformer



MODEL B

$4.00

Postage 10c

with W D-11 TUBES

It is the peer of them all.

Write for Free Catalog!

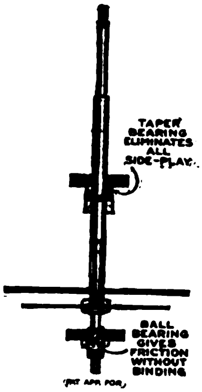
Dealers: Send for discount sheet on Rhamstine* Products!

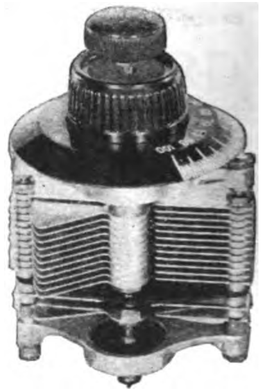
Manufactured by

J. THOS. RHAMSTINE*

2152 E. Larned St. Detroit, Mich.

****Maker of Radio Products***


TAPER BEARING ELIMINATES ALL SIDE-PLAY.
BALL BEARING GIVES FRICTION WITHOUT BINDING
(PAT. APP. FOR)



A Vernier Variable Condenser That Is Built Right!

This condenser is built to get the best results and to give 100% satisfaction. Tension and adjusting accomplished by tightening end thrust plug causing a thrust between a hardened steel ball and the 45 deg. tapered brass bushing. This insures smooth running and a contact equal to a soldered joint. This feature also takes up wear for years to come.

Made in most popular sizes with aluminum plates, cast end brackets with 1-in. dia. Bakelite bushing—a perfect insulator of high dielectric strength.

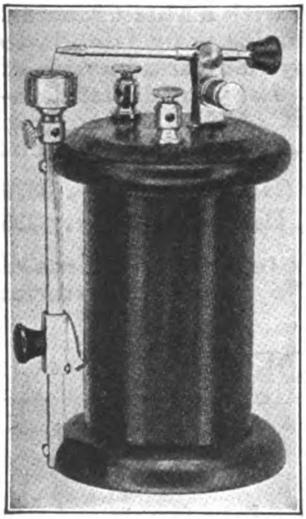
Jobbers and Dealers, write for discounts.

The Lombardi Radio Mfg. Co.

73 Minerva St. Derby, Conn.

Crystal Receiving Set

$2.50



The Ritter Grand Crystal Set is everything that the beginner could wish for. This set will tune up to 600 meters and will receive broadcasting stations from 25 to 50 miles. It is made of the best material with mahogany finish, stands six inches high and has the guarantee of high-class receiving qualities with a 100% rating by the Technical Department of POPULAR RADIO.

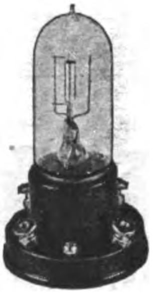
Free circular of set with instructions on how to direct your aerial sent upon request.

To dealers: This is the latest crystal set placed before the public and all sample orders from dealers have been followed by quantity orders.

We invite inquiries.

RITTER RADIO CORPORATION

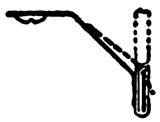
232 Canal Street New York City



It's the contact that counts

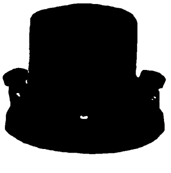
The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.



The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each



ALDEN-NAPIER CO.

Dept. C 52 Willow Street

Springfield, Mass.

NA-ALD

—And they're all talking at once these nights! If you want what you want when you want it, you might as well stop struggling with single-circuit receivers.

Under present conditions, with several hundred powerful broadcasting stations all operating on one narrow wave band, the single-circuit receiver is utterly inadequate to give you satisfactory results.

The Paragon three-circuit receiver gives you the station you want when you want it—*and no other.* You can tune in accurately on any station and get a clear, complete program without interruption or disturbance.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

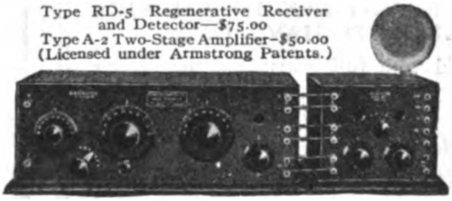
An Illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

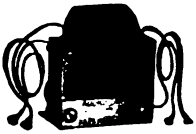
Also Manufacturers of PARAGON

Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers


Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)

PACENT AUDIOFORMERS

Ideal for 1½ Volt Tubes, as well as others



No. 25A—PACENT AUDIOFORMER
Price
$4.00

No. 25—PACENT AUDIOFORMER
equipped with binding posts
Price
$5.00

Compact, convenient for mounting, especially designed for radiophone reception — amplifies all audiofrequencies, without distortion (not a "one frequency" transformer).

Don't Improvise "PACENTIZE"

Send for Bulletin P-3

PACENT ELECTRIC COMPANY
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Executive Offices: 22 Park Place, New York, N. Y.
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Philadelphia
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How to build the Reinhartz Receiver

is told, complete with illustrations and diagrams, in the latest addition to our FREE looseleaf, handbook catalog.

Write for your copy today—ask for "Chi-Rad" Handbook, Edition RRpr.

Amateurs find the Reinhartz hookup by far the simplest yet designed. In efficiency it rivals the Armstrong and other well-known circuits.

Parts necessary for building your Reinhartz receiver are also listed and described in the "Chi-Rad" handbook—your order, no matter how small, will be dealt with the usual "Chi-Rad" assurance of satisfaction.

free

CHI-RAD Handbook

Chicago Radio Apparatus Co.
415 South Dearborn Street
Chicago

RADIO "BOWENG" RADIO
(Patent Applied For)

LATEST WONDERFUL INVENTION
NEW INTERIOR ANTENNA

With this device your receiving set will function perfectly without ground wires as one does in airplane service

Why Spend Money

For outside antennas, or have the unsightly, so-called loop antenna in your home,

When you can—save expense and have more enjoyment with this small device?

Unsurpassed for collecting the etheric waves, and the sharp tuning eliminates interference to a wonderful extent.

EVERY RADIO FAN IN AMERICA SHOULD HAVE ONE

Postpaid with full instructions on receipt of money-order for only $2.50. Fully guaranteed. Order one today.

Dealers Write for Special Price List

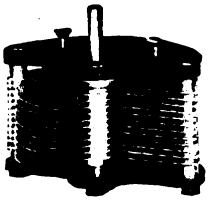
INTERIOR ANTENNA COMPANY
P. O. Box 262 MALONE, N. Y.

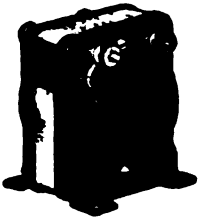
For Clear-Tone, Long-Distance Radio Reception

USE ONLY "UNITED"
CONDENSERS AND TRANSFORMERS

Products of an $800,000.00 plant, equipped with the highest type of precision machinery, manned by expert mechanics, and backed by a seasoned staff of radio engineers.

The guarantee of this old established Electrical House stands back of our products.





"UNITED" VARIABLE CONDENSERS

Cannot short-circuit, because hard aluminum plates are held mechanically in true and permanent alignment. Ends are Bakelite; trimmings brass, nickel plated.

Prices, without dial or knob

43 plate	$4.50	5 plate	$2.75
23 plate	4.00	3 plate	2.25
11 plate	3.50		postpaid

"UNITED" AUDIO-FREQUENCY AMPLIFYING TRANSFORMERS

A fine example of precision-workmanship; completely shielded, in shell of original design. Amplifies detected signals, bringing them to phone or loudspeaker, clear, strong, pure-toned. **Price, Postpaid, $4.50**

Try your dealer first, before ordering by mail. Send name and address of dealer with order. Circular free.

UNITED MFG. & DISTRIBUTING CO.
536 LAKE SHORE DRIVE CHICAGO, ILL.

Do You Want a *Real* Headset?

The Dictograph is the Best Headset in the World at *any* Price

This is the same supreme Dictograph Headset that has always sold for $12—same in quality, same in guarantee, same in everything but the price—$8 complete. Made by the makers of the world standard Dictograph products—the marvelous "Acousticon" for the Deaf, the famous Detective Dictograph, the Dictograph System of Interior Telephones and the Dictograph Radio Loud Speaker for the Home.

Dealer: Order through your jobber or write direct for names of authorized distributors of the best and fastest-selling Headset on the market today.

Read a few of the many letters received from Dictograph Headset users

U. S. Marine Hospital No. 43 Ellis Island, N. Y.

"The undersigned has for the past sixteen years been an amateur, commercial, and government operator, and has used every known make of radio receiver on the market today. On April 21st one of your Type R-1 3000 ohm receivers was purchased and it can be safely said without dispute that they are absolutely the best radio receivers on the market today, bar none."

C. H. West, U.S.P.H.S.

Havana, Cuba:

"In my long-distance receiving set have four pairs of phones, a 4000 ohm French make, two pairs of — — and a pair of your Dictograph 3000 ohms and I assure you that none of the others afford me the service I get from the Dictograph. The Dictograph gives me a truer, clearer tone than all the others combined. I use them in extremely long-distance work (phone). I hear Chicago, Schenectady, Iowa, and Frisco."

David E. Masnata

La Porte, Ind.

"I have been experimenting with Radio for the past year; in my experience have tried out 14 different headsets, including the — which I purchased for $16.50. I at last have found the ideal phone where tone quality excels, and harshness is eliminated, and I cannot express myself in words as to the wonderful results I have obtained."

J. T. Bachman

Madison, South Dakota

"We are using a Dictograph Headset, also Dictograph Loud Speaker. Both are O.K. In fact, I would not trade my headset for any other I have ever listened through."

Dan D. Coutts

The Standard of the World

Type R-1, 3,000 ohms, for all types of crystal and vacuum tube receiving sets. Complete with 5-foot cord. If your dealer is sold out, order direct from us. Immediate delivery.

Stop into your dealer's today and listen in with this supreme Headset. Note the difference. Insist on Dictograph Products. Every instrument fully guaranteed.

THE DICTOGRAPH PRODUCTS CORPORATION

Suite 1315 **220 West 42nd Street** **New York City**
(Branches in All Principal Cities)

Count the cost—

Two stages with 2 popular $5 transformers— Total amplification, 36.	**One stage** with 1 AmerTran— Total amplification, 38.6.
Equipment cost:	Equipment cost:
2 transformers . $10.00	1 AmerTran . . . $7.00
2 tubes 13.00	1 tube 6.50
2 sockets 2.00	1 socket 1.00
2 rheostats 3.00	1 rheostat 1.50
Total $28.00	Total $16.00

The AMERTRAN

super audio frequency amplifying transformer It is doubtful if the substitution of any one thing in a radio set could make such a notable improvement as the installation of an AmerTran.

Price $7.

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

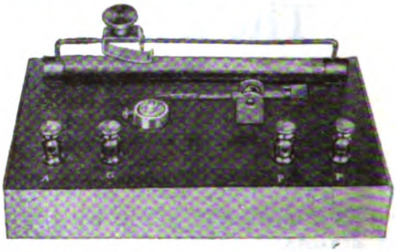
DEPENDABLE TESCO LINE

INSTRUMENT MAKERS SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

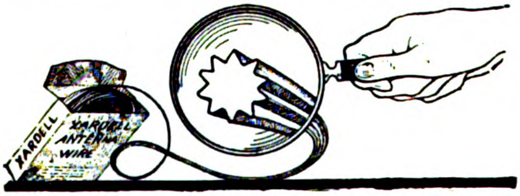
Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



TYPE "A" (Shown in cut) . . **$1.25**
TYPE "B" De Luxe . . **$5.00**
Without Phones or aerial

Sent prepaid upon receipt of express or postal money orders.
Money refunded if not absolutely satisfactory.
Dealers and Jobbers write for discounts.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.



Something Brand New in Antenna Wire

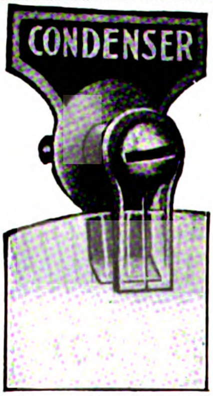
$2.00 PER HUNDRED FEET

That will at once appeal to you. It is different and better than any makeshifts to date, being hard drawn from the finest copper having a corrugated surface with 10 collecting points on its circumference. This gives a greater collective and gathering surface. The result is extreme sensitiveness, and an increase in the range and clearness of any set from the simplest crystal type to the finest V. T. Receiver.

Packed in neat cartons of 100 feet, 200 feet and 500 feet.

Dept. R *Postage Paid*

Xardell Corp.
UTICA, NEW YORK



Somerville Terminal Tags, 5c

fit under binding posts like washers and make engraving unnecessary.

Antenna	Hi-Voltage+
Ground	Hi-Voltage—
Input	Lo-Voltage+
Output	Lo-Voltage—

Mail Order Specials
$8 Holtzer-Cabot 2200 ohm Head-Set— First Quality—Guaranteed **$4.**

FEDERAL JR. CRYSTAL RECEIVER
ORIGINAL BOX AND GUARANTEED, $9.95
ONLY A FEW AVAILABLE

$5.50 AMRAD BASKETBALL VARIOMETER $4.95
6.25 AMRAD BASETBALL VARIOCOUPLER 5.45
SOMERVILLE DIAL & POINTER, EXTRA, $1.00

We offer 24-hour mail order service on "General Radio Co.'s" parts. See their advertisement on another page of this issue and mail us your order.

Radiotron WD.-11 tube, 1½ volts $6.50
Eveready 22½ volt large battery 3.00
Catalog for Stamp

SOMERVILLE RADIO STORES
43 CORNHILL **BOSTON, MASS.**

You Do Not Have to Look Over Your Shoulder to See the New MOON

Go to your nearest dealer and ask him to show you The Model C1 Moon Receiving Set "Satterlee Antennaless."

Price
$127.50

with solid mahogany cabinet-piano finish.

Showing Model C 1 with Compartments for "B" Batteries

The set that you will eventually buy—because of its selectivity, beautiful tone and long distance range, using no aerial whatsoever.

Another MOON Product
"The Naturaltone Loudspeaker"

Hear this non-metallic loudspeaker at your dealer's. Test it alongside of others.

Price, $27.50
Mahogany finished cabinet

Send 2 cent stamp for literature

Dealers and Jobbers: If you have not these in stock, write us at once.

THE MOON RADIO CORPORATION
Manufacturers of Ultra-fine Receiving Sets

12 Diagonal Street
Long Island City, N.Y.

Sales Office
552 Seventh Avenue
New York City

LASTS 5 YEARS

Sidbenel "B" BATTERY

Exceptionally powerful. Makes weak signals strong. A single charge will last six months, recharged (for less than ½c) from any lamp socket or farm lighting generator. Patented high ampere plates charged and formed before leaving the factory.

Positively eliminates battery noises often blamed on static.

Container will not leak and is made of genuine hard rubber. Size 2½" x 3" x 4½".

You assemble the battery easily and pleasurably in less than ten minutes. Complete illustrated directions with each battery.

Large illustrated circular on request.

Price, 22½ volt, unassembled	$4.25
assembled	4.65
Rectifier for A C	.35

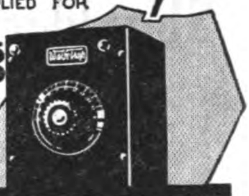
Sidbenel Radio Equipment Mfg. Co., Inc.

1667 Jerome Avenue New York City

Wave Trap TRADE MARK

PATENT APPLIED FOR

The Missing Link in RADIO



Stops Interference!

Get rid of the interference that is spoiling your evening concert. By using the "WAVE TRAP" you eliminate it.

It is installed in a minute by changing only one connection, and is indispensable on any receiving set with any type of antenna. It is mounted on a formica panel in a handsome mahogany finished cabinet 6x5x6 and is a high grade instrument throughout.

8^{50} CHARGES PREPAID

Ferbend Electric Co.

21 E. SOUTH WATER ST.

CHICAGO

Circular on request.

Make your Crystal Set 100% Efficient by Using

MPM

"Million Point Mineral"

The WORLD'S GREATEST RADIO CRYSTAL

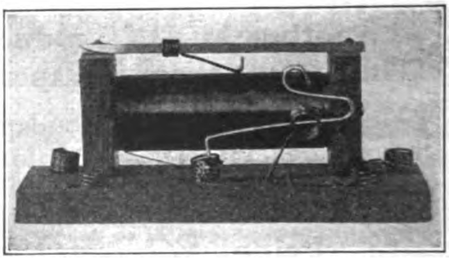
THE discovery of M. P. M. has revolutionized the possibilities of ordinary crystal sets. Concerts have been clearly heard over 600 miles. M. P. M. is super-sensitive—reproducing from every point on its surface. It increases audibilty as well as radius, and makes the purchase of an extensive tube set unnecessary.

Send 25c and name of your Radio Dealer for a sample M. P. M. Crystal—concert-tested and guaranteed. Address Dept. PR.

M. P. M. SALES COMPANY

247 S. Central Ave. Los Angeles, Calif.

A Radio Wonder, .98 cents



Only .98c for This Efficient Little Radio Set

Why be without a radio when you can have one for less than a dollar? This splendid little set will get any station within thirty miles, and will give just as satisfactory results as the larger and more expensive ones.

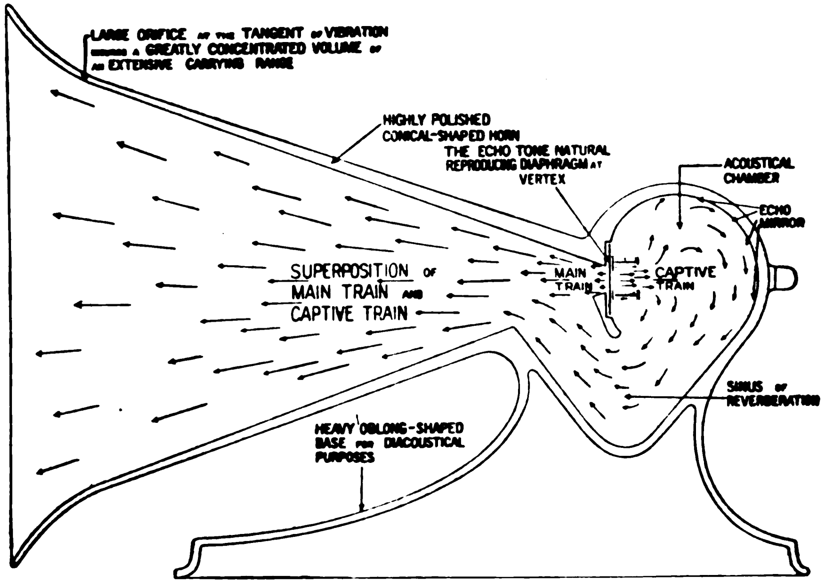
Each outfit is equipped with an extra-sensitive piece of Standard Special mineral, and is complete when you receive it. No accessories are needed. Full directions sent with each set.

The demand is increasing every day. Be sure to order yours at once. Include ten cents with your money order to cover postage.

GERING SPECIALTIES CO.

274 HALSEY STREET, NEWARK, N. J.

AT LAST!—A Faithful Loud Speaker!


LARGE ORIFICE AT THE TANGENT OF VIBRATION ENSURING A GREATLY CONCENTRATED VOLUME OF AN EXTENSIVE CARRYING RANGE
HIGHLY POLISHED CONICAL-SHAPED HORN
THE ECHO TONE NATURAL REPRODUCING DIAPHRAGM AT VERTEX
ACOUSTICAL CHAMBER
ECHO MIRROR
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
MAIN TRAIN
CAPTIVE TRAIN
SINUS OF REVERBERATION
HEAVY OBLONG-SHAPED BASE FOR DIACOUSTICAL PURPOSES

Patent Pending

RETAIL PRICE $35.00

ECHO-TONE

Our Standing Offer

To whomsoever that will demonstrate in our laboratories a standard make loud speaker which will, in comparative tests, excel ECHO-TONE in tone quality and volume and which will also be more faithful in its reproduction, we will present an ECHO-TONE free of charge.

Williams Radio Company

Qualified Dealers Wanted

Introducing ECHO-TONE, throut the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has been allotted for your district.

Features Which Make *Echo-Tone* Paramount

It is more than a horn. It is an acoustical instrument, THUS GIVING A FAITHFUL REPRODUCTION WITH VOLUME.

It is equipped with the Echo-Tone Natural Reproducing Diaphragm whose natural period of vibration is such that IT WILL NOT RESONATE DURING PERFORMANCE.

With its volume and clarity, head telephone sets are not needed to 'tune in.' NOW THE WHOLE FAMILY CAN ENJOY RADIO.

Being Mahogany grained—wood finish, having a 14½-inch conical shaped horn polished inside and being casted aluminum, for diacoustical purposes it weighs 16 lbs., IT IS A BEAUTIFUL PIECE OF FURNITURE.

Demonstrated in your home upon your own set

If there is no Echo-Tone dealer near you, send a check or money order for $35.00 direct to us. Upon receipt of the money, we will immediately express an Echo-Tone to you. Try it out upon your own set. If it does not prove entirely satisfactory to yourself and family, replace it in its wooden box and give it to the express man consigned to us. Simply mail us the express receipt, not even necessary to write us your reasons for returning it. As soon as we receive the receipt, we will refund your money, without even waiting until we receive the instrument. Remember, we pay express charges both ways, making it just as convenient as though you were buying in your own city.

WILLIAMS RADIO COMPANY

1438 WASHINGTON BLVD. WEST **DETROIT, MICH.**

Warren Radio Loop, cut away to show construction

What You Can Do With the—

Warren Radio Loop

SELECT your stations, just by turning the loop in the direction of the station desired.

MAKE any set portable. This compact aerial can be packed right with the set.

TUNE on ranges from 175 to 18,000 meters, according to type loop.

MANY other advantages described in Bulletin I 102.

If your dealer is out of Warren Radio Loops, send us your order, with his name.

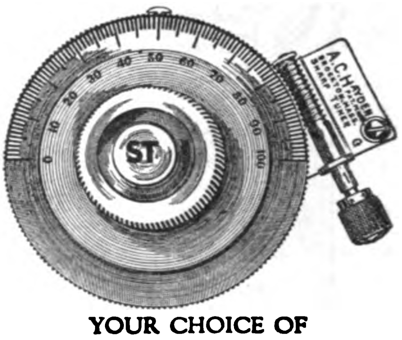
A type for every purpose

Sold by dealers who sell the best

Type-A-787 (300-700 meters) 6 inches square -non-directional.....$10
Type-A-1236 (175-1000 meters) 6 inches square—non-directional...$12
Type-B-2587 (300-700 meters) 18 inches square—directional........$20
Type-BL-2520 (200-18,000 meters) with honeycomb coil. 18 inches square—directional......................................$25

V-DE-CO RADIO MFG. CO. Dept. F. **Asbury Park, N. J.**

Use ACH SHARP TUNER DIALS



YOUR CHOICE OF

Rough tuning with dial, or one thousandth ot an inch in either direction with the Sharp Tuner Knob. Both controlled by center Knob ST. Eliminates a Vernier condenser.

Can be installed on any set, making difficult tuning easy.

GUARANTEE

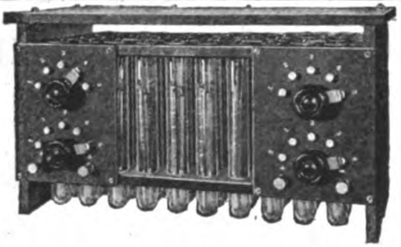
If purchased direct and you find the ACH Dial does not warrant your own personal award of merit, return it and we will refund your money. What better guarantee can we give?

Price of ACH 3-inch Dial Complete $2.50

A. C. Hayden Radio & Research Co.

BROCKTON, MASS., U. S. A.

Mail Orders sent prepaid in U. S. A.



KICO Radio Storage "B" Batteries for EFFICIENT Receiving

1. KICO "B" batteries allow single cell variations by means of switches mounted on panels. (The first in the market with this feature.)
2. Alkaline type.
3. Rechargeable from your 110-volt A. C. line in connection with the rectifier supplied.
4. One charge lasts from three to six months in the detector plate circuit.
5. Neat, efficient and compact.
6. Unlimited life.
7. Your money back if unsatisfied within a 90-day trial.

	(Plain)	(With Panels)
16 cell 22 volt	$6.50	......
24 cell 32 volt	8.00	$12.00
36 cell 48 volt	10.00	14.00
50 cell 68 volt	12.00	17.00
78 cell 100 volt	16.00	21.00
108 cell 145 volt	21.00	26.00

"A" and "B" Battery Literature gladly furnished

KIMLEY ELECTRIC COMPANY
1357 FILLMORE AVENUE BUFFALO, N. Y.

PRICES SMASHED

Each sale has created new friends and customers, with the result that we now announce drastic reductions in our quality lines. All goods prepaid. Send card for complete list. You'll be surprised. You'll tell your friends. A sample saving follows—

Complete Regenerative Vacuum Tube Set

(Knocked down. Approx. range 1000 miles.)

	Our price	Others
Panel 7" x 12"—Bakelite—drilled	$1.75	$2.50
Cabinet of 3 ply wood to fit above panel	1.50	2.50
Two 3" dials @ 35c each	.70	1.40
16 switch points with nut @ 1c each	.16	.48
4 switch stops with nut @ 1c each	.04	.12
8 nickel plated binding posts @ 3c each	.24	.48
2 switch levers @ 25c each	.50	.90
1 filament rheostat. Highest grade	.65	1.10
1 vario-coupler with 7 multiple, 7 single taps	2.25	4.00
1 23 plate variable condenser. Built right	1.95	3.50
1 tube socket—High grade	.45	.85
1 grid condenser and leak	.10	.25
1 phone condenser	.10	.25
1 support for tube socket	.15	.25
10 feet of spaghetti tubing @ 5c per foot	.50	.84
15 feet copper connecting wire	.30	.45
Blueprints showing details to assemble outfit	.10	.25
	$11.44	$20.12

Other articles taken at random from our list are:

Detector tubes—Cunningham—New. NOT rebuilt	$4.25	$5.00
Crystal detector—Enclosed type	.60	1.00
Transformer—Audio frequency	2.95	4.50
Loose coupler—Knocked down with wound coils	3.75	
Variometer—Hardwood stators 4¾" square. Assembled Workrite type	2.45	4.00
Frost Fones ....2000 ohms	3.95	5.00
Kelloggs ....2400 ohms	8.75	12.00
Western Electric ....2200 ohms	9.25	12.00
Two stage amplifier—Knocked down. Cabinet and drilled panel	12.95	23.50
Blueprints giving detail of two stage amplifier	.10	.25

Send for full list today or order from above. Goods sold subject to return for rebate or exchange. YOU SIMPLY MUST BE PLEASED.

RADIO PARTS MANUFACTURING CO.
Dept. "P" 2150 Montclair Detroit, Mich.

Heard with A MU-RAD Receiver

And A 2 Foot Loop Aerial

(The MA-13)

From
NEW YORK

Davenport
830 Miles
Kansas City
1040 Miles
Fort Worth
1285 Miles
Havana
1567 Miles

From
ST. LOUIS

Manitoba
900 Miles
Montreal
1000 Miles
San Francisco
1820 Miles
Honolulu
4278 Miles

From
DETROIT

Fort Worth
1092 Miles
Havana
1680 Miles
Calgary
1667 Miles
Porto Rico
2036 Miles
San Diego
2070 Miles
Los Angeles
2070 Miles
San Francisco
2210 Miles

From
CLEVELAND

Fort Worth
1050 Miles
Denver
1200 Miles
Salt Lake City
1530 Miles
Havana
1671 Miles
San Francisco
2180 Miles

From
CHICAGO

Havana
1621 Miles
Los Angeles
1840 Miles
San Francisco
1955 Miles

The New
Star in
the Radio
World

They copied all they
could copy,
But they could not
copy our mind;
We left them tearing and swearing
A thousand miles
behind.
—*Kipling.*

Why MU-RAD Excels

1. **Unequalled Sensitivity**—Exceeds the sensitivity of the average set many times. The above record demonstrates this.
2. **Fine Selectivity**—Permits differentiation of stations 1% off tune.
3. **Simple Operation**—All tuning can be done with one hand.
4. **1,000 Mile Reception—Guarantee** goes with every set.
5. **Distinctive Appearance**—Solid mahogany cabinet, *Radion* panel, highly polished.

Ask for a Demonstration of
MU-RAD Receivers

The MU-RAD dealer in your town will gladly let you listen in on either type MU-RAD receiver

Attractive Proposition for Dealers

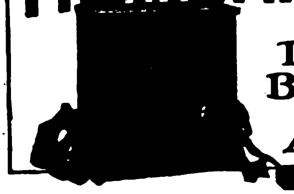
MU-RAD Laboratories, Inc.

809 Fifth Avenue Asbury Park, N. J.

Two Types
MU-RAD SETS

Type MA-12 3-Stage R-F and Detector	**$128**
Type MA-13 3-Stage R-F, Detector & 2 Stages A.F.	**$160**

HOMCHARGE *your* RADIO BATTERY *for* A NICKEL



Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery over night for a nickel without removing it from your living room. No muss—no trouble—no dirt—requires no watching.

After the concert, connect to any lamp socket, snap the clips on your battery and "turn in." While you sleep the HOMCHARGER is silently charging your battery, the charging rate being governed automatically. In the morning it is fully charged. No OTHER battery charger can boast of such *quick* and *economical* performance.

The HOMCHARGER is the only battery charger combining all of these NECESSARY HOMCHARGING features — SELF-POLARIZING —FIVE to EIGHT AMPERE charging rate—UNDERWRITERS' APPROVAL—beautifully finished in mahogany and old gold—UNQUALIFIEDLY GUARANTEED. OVER 60,000 NOW IN USE.

Sold complete with ammeter, etc., by all good radio and electrical dealers for $18.50 ($25.00 IN CANADA).

See the RADIO HOMCHARGER DE LUXE at your dealer's or write direct for our FREE circular, showing why the HOMCHARGER is the BEST battery charger at any price.

MOTORISTS—The HOMCHARGER will also charge your AUTO battery.

The Automatic Electrical Devices Company

132 West Third St., Cincinnati, O.

Largest Manufacturers of Vibrating Rectifiers in the World

Compare These Prices

WHY PAY MORE WHEN YOU CAN GET ROCK BOTTOM PRICES FROM US

Just glance over our list and send us your Money Order. Twenty-four hours after receiving your order it is on its way to you.

LIST PRICE		OUR PRICE
$ 5.00	Radiotrons UV-200	$ 4.25
6.50	" UV-201	5.75
16.00	Baldwin Phones, type C	12.00
7.75	" Units Loud Speakers	6.00
8.00	Federal 2200 Ohm Phones	6.00
8.00	Brandes Superior "	7.00
5.00	Acme Transformers	4.25
1.00	Double Jacks	.60
.70	Single "	.50
2.50	Bull-Dog Plugs	1.25
	Contact Points, per doz	.15
	Switch Levers, 1½" radius	.25
45.00	Magnavox	38.00
1.50	100 ft. Stranded Aerial Wire	.60
.50	Aerial Insulators	.25
1.00	100 ft. Solid Aerial Wire	.40
75.00	Paragon RA-10 Set	68.00
25.00	90 ampere guaranteed Storage Battery	18.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.75
1.00	Vacuum Tube Sockets	.65
18.50	Homchargers	15.50
3.50	B. Batteries volt meters 0-50 V	2.75
55.00	Western Electric New Style Loud Speakers	42.75
.75	Rheostats	.60
3.00	B. Batteries	2.25
2.50	" "	2.00
1.75	" "	1.10
1.50	Dials	.75
1.00	"	.40
2.75	De Forest Detectors	1.95
.75	Sockets	.60
6.50	Westinghouse WD-11 Tubes, operated on 1 Dry Cell	5.98
1.00	Westinghouse WD-11 Sockets	.65
4.50	Thordarson Transformers	3.75
2.00	Potentiometers	1.25
	½ Megohm Grid Leaks	.60
	1½ " " "	.65
1.00	Grid Leak Holders	.65
1.00	Double Phone Cords	.60
.50	Single " "	.35
	Duplex Phone Adapters, fits Edison, Victor or Columbia	1.75
	Genuine Bakelite Panels, per sq. in.	.02
	Spaghetti, per ft.	.09
12.00	Genuine Western Electric Signal Corps V.T.-2-Tubes	9.00
112.00	De Forest type Honeycomb Set, special Mahogany Cabinet	65.00
3.00	Racony Electric Light Aerial	2.00
35.00	Audmiax Loud Speakers	18.50
6.50	Turney 3,000 Ohm Phones	4.25
4.50	Diamond 2,000 Ohm Phones	3.75
5.00	Fischer Variometers	3.75
6.00	" "	4.75
5.00	" VarioCouplers	3.75
6.00	" "	4.75
8.00	Atwater-Kent Variometers	7.00
8.00	" " VarioCouplers	7.00
5.00	Pathe Variometers	3.75
14.00	Atwater-Kent Mounted Vario-Couplers	11.75
16.00	Atwater-Kent 2-step amplifier	13.75
8.50	Everet Head Phones, 3,000 Ohms	4.95
1.50	Thordarson Rheostats	1.15
	Bus Wire for wiring sets, per ft.	.02

Honeycomb coils, all sizes, 20% discount. Space being limited, we are obliged to omit many items.

Write for our Quotations

Cut Rate Radio Co.

Dept. A P. O. Box 472 Newark, N. J.

IMPORTANCE of AMPLIFICATION

The simplicity of audio frequency amplification still makes it the most practical and popular type. It is adapted to all types of receiving sets and is free from tuning adjustments. With the proper choice of amplifying instruments, audio frequency amplification is accomplished with a minimum of distortion.

TYPE 231-A

AMPLIFYING TRANSFORMER

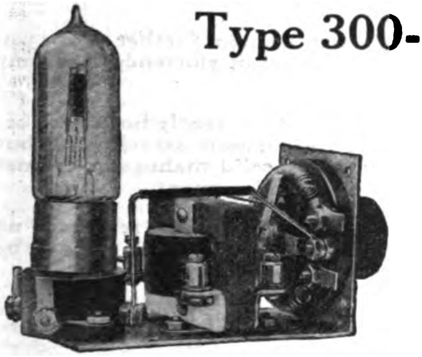
The amplifying transformer is the most important of these instruments. The General Radio Co. was the first company to have available a closed core audio frequency amplifying transformer. This was before the United States entered the war. Many of these transformers were supplied to the army and navy during the war, and with the return of amateur radio after the war thousands have been supplied for use in this country and abroad.

Our latest type is the 231-A. This transformer is designed to give the maximum of amplification possible without distortion. It is the result of careful engineering design. It is particularly adapted to the WD-11 and UV-201 tubes. The electrical constants of the windings are as follows:

	Primary	Secondary
Direct current resistance, ohms	1,100	5,500
A. C. Resistance at 1000 cycles, ohms	11,000	130,000
Reactance at 1000 cycles, ohms	66,000	700,000

PRICE, COMPLETELY MOUNTED $5.00

Type 300-A Amplifier Unit



For those who desire a compact amplifier unit, we recommend the type 300. This unit consisting of our Type 231-A Amplifying Transformer, Type 255 Filament Rheostat, and Type 282 Tube Socket mounted on a nickel finished brass plate, is all ready for the external connections. It may be used as a table unit or mounted behind a panel, in which case only the rheostat knob projects. Connections are properly made so as to keep the unit from howling.

PRICE $7.50

For those who desire to use the UV-201 tubes, this unit may be supplied with a standard base socket—our Type 156.

TYPE 300-B AMPLIFIER UNIT, PRICE . . . $8.00

Send for NEW FREE RADIO BULLETIN 913-U and learn about these instruments

GENERAL RADIO COMPANY

MASSACHUSETTS AVENUE AND WINDSOR STREET

CAMBRIDGE 39 MASSACHUSETTS

Do not confuse the products of the GENERAL RADIO CO. with those of other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific instruments for many years. It has no affiliation with any other company.

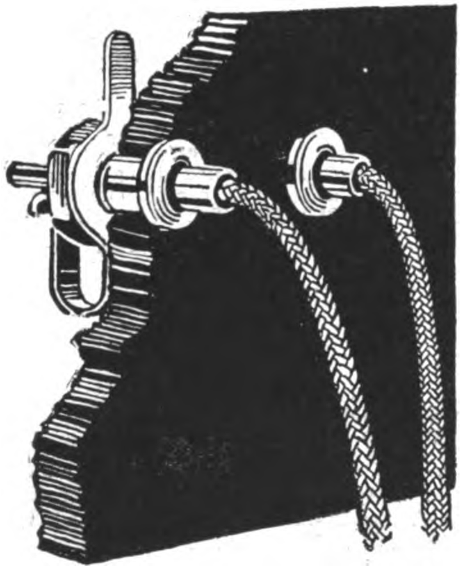
Standardize on General Radio Equipment Throughout

Read Why You Should Use

UNION-RADIO PHONE TIP JACKS

(Pat. Applied For)

25c A PAIR



Here's the Radio device that you have been waiting for. These Phone Tip Jacks assure quick connection and a positive contact. They replace unsatisfactory binding posts. Soldering lug incorporated but use optional.

Accommodate any standard round phone tip and several sizes of bare wire. Great for W D 11 connections and coil mountings. Save buying expensive telephone plugs and jacks. They live up to the Union Radio Standard of Quality. Guaranteed to satisfy. Only 25c a pair.

FOR ASSURED RESULTS

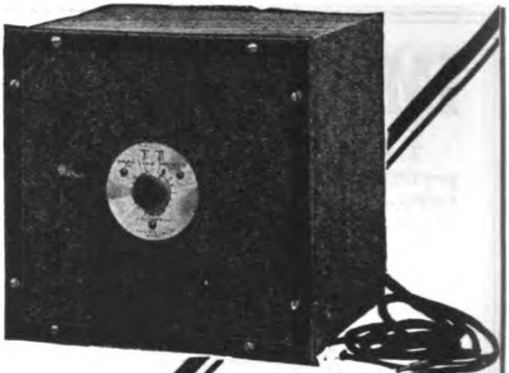
you should "try out" Union Radio Tip Jacks, Variable Condensers, Rheostats, Vacuum Tube Sockets, Condensite Dials, Complete Receiving Sets and Two Step Amplifiers.

Union Radio Apparatus and Accessories are sold by most good dealers. If you can't obtain them from your local store mail your order to us. Write for a copy of our Catalogue A Radio Apparatus.

Wholesalers and Retailers:

Write for our liberal proposition. Dealers' Catalogue A and Price List, also samples sent on request.

UNION-RADIO-CORPORATION
200-MT. PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE-116-WEST-32nd-STREET



DON'T CONFUSE

IT WITH ORDINARY LOUD SPEAKERS

THE TIMMONS TALKER is possessed of most unusual tonal qualities—it provides adjustable amplification, too, which is decidedly advantageous when it is desired to soften the volume of tone for living room or increase the volume for larger audiences.

THIS arrangement further allows you to get maximum efficiency from any set.

THERE is no unsightly horn with ordinary head-phone attachment, but a beautiful, solid mahogany cabinet which is an adornment.

NO separate batteries required, no complicated mechanism. For sale by most worthwhile dealers.

DEALERS

T IMMONS T ALKER

We have a most attractive proposition that will appeal to both dealer and jobber.

We will be glad to ship any dealer or jobber (with privilege of return) an instrument C. O. D. for inspection.

J. S. TIMMONS

337 E. Tulpehocken St.
PHILADELPHIA, Pa.

Every day new evidence comes to us unsolicited of the remarkable results achieved with various models of Crosley Radio Receiving Sets.

Sebring, Fla., using a Model X Crosley Receiver—price only $55 for this four tube set—"clearly hears three selections and two announcements from K. D. Y. X. at Honolulu, 4900 miles away."

Centerburg, Ohio, receives 1920 miles from Los Angeles, Cal.; 950 miles from Fort Worth, Tex.; 1200 miles from Havana, Cuba; and 750 miles from South Dartmouth, Mass. A Crosley Model VI, a two tube set that costs but $28 was used.

With a Crosley Harko Senior—a man from Rock Valley, Iowa, had these very satisfactory results—"I have tested out the Harko Senior and am ready to agree that you made no overstatements. We have heard Winnipeg, Canada; Dallas, Tex., and many other points."

These are just a few quotations from among the hundreds that satisfied Crosley users are constantly sending us.

No matter what Crosley Instrument you choose, you may be sure that it will perform everything claimed for it—and more besides.

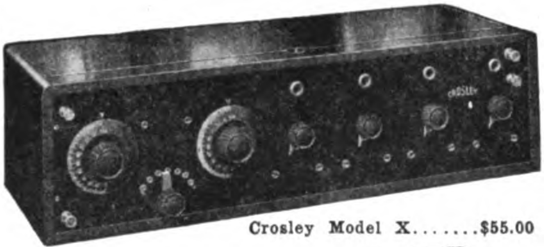
Every Crosley Model, ranging in prices from $16 to our beautiful console Model XXV at $150, offers the highest at the lowest cost.

Listen in on a Crosley and Be Convinced.

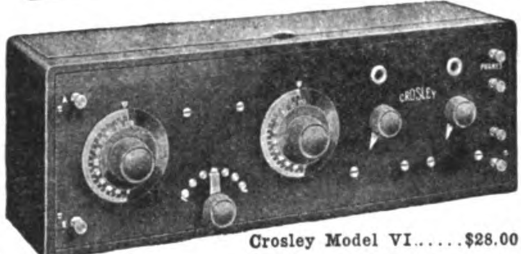
We also manufacture a complete line of parts for those who wish to make their own outfit. Among these are Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario-Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

CROSLEY
Better—Costs Less
RADIO RECEIVERS
CROSLEY MFG. COMPANY
316 Alfred Street Cincinnati, Ohio

THE THREE MOST POPULAR RECEIVERS ON THE MARKET



Crosley Model X.......$55.00



Crosley Model VI.....$28.00

The Crosley Harko Senior, a one-tube, non-regenerative receiver of which thousands have been sold. Retail prices $14, $15 and $16. Similar instruments but using Armstrong Regenerative Circuit manufactured under license under Armstrong Patent No. 1,113,149, dated Oct. 6, 1914, can be obtained from the manufacturers, The Precision Equipment Co., Powel Crosley, Jr., President, Cincinnati, Ohio. Write them direct.

Unequalled Quality of Volume and Purity of Tone

are assured by adding to your Radio Set the newly constructed 100% perfect Audio Frequency Transformer R T-A2. This Audio Transformer is exactly the same shape and size as the R T-6 Radio Transformer, but the color is brown, thus making a neat match when both Radio and Audio transformers are used together. Why build up beautiful tone quality with Radio Frequency and destroy it with inferior Audio transformers? For best results on both tone and distance, use Radio Service Laboratories Radio Frequency (R T-6 and R T-6A) in the black case, retail price $6.00, and Audio Frequency (R T-A2) in the brown case, retail price $6.50.

Order by type number, accept no substitute and remember that all Radio Service Laboratories Transformers are individually triple tested and unconditionally guaranteed. For sale at all reliable electrical or Radio Stores or order direct from us.

Send ten cents for new booklet on Radio Frequency with schematic diagrams—a most valuable and helpful publication for the radio amateur and expert.

RASLA SALES CORPORATION
National Distributor
10 East 43d St. :: New York City
Dept. P

RT

A2

RT

A2

The new member of the Rasla Family — in the brown case.

BRILLIANTONE RADIO PRODUCTS

Dept. C—874 Columbus Ave., New York

$1.00 Brings any one of these Combinations quickly to you

No. 1

100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lighting switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

No. 2

1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.

No. 4

1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.
1 Spool No. 24 cotton covered wire, 375 feet.
1 Hardwood Rotor.
All the above merchandise guaranteed or money refunded.

— — — — — — — — CUT HERE — — — — — — — —

Please Check Before Items Desired—Fill in Coupon and Mail

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐ B.R.P. Rheostats, air cooled (Tapered Type) $1.00
☐ B.R.P. Potentiometer (240 ohms) 1.00
☐ B.R.P. Moulded Sockets (unbreakable) 1.00
☐ B.R.P. Audio Frequency Transformers (11 to 1) 4.00
☐ B.R.P. Variometer (mahogany inlaid) 3.00
☐ B.R.P. Variocouplers (Panel and Laboratory Type in one) 3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐ 3 Plate, capacity .00005 .... $1.50
☐ 23 Plate, capacity .0005 .... 3.00
☐ 43 Plate, capacity .001 .... 3.50

TYPE "B"—ALUMINUM ENDS

☐ 3 Plate, capacity .00005 .... $1.00
☐ 23 Plate, capacity .0005 .... 1.75
☐ 43 Plate, capacity .001 .... 2.25

STANDARD MERCHANDISE AT REDUCED PRICES

☐ $4.50 Thordarson Amp. Transformers (Audio) $3.00
☐ $7.00 UV712 Audio Frequency Transformers (Radio Corp.) 6.00
☐ $6.50 UV1714 Radio Frequency Transformers (Radio Corp.) 5.50
☐ ZETA Radio Frequency Transformer 3.50
☐ $5.00 W.D. 12 transformers for W.D. 11 tube 4.00
☐ Brandes "Superior" (2200 ohms) 6.75
☐ Murdock (3000 ohms) 5.00
☐ Klosner Vernier Rheostat 1.00
☐ Bradleystat (Best Vernier) 1.65
☐ $1.00 Freshmen variable gridleak and condenser .75
☐ .75 Freshmen variable gridleak 0 to 5 meg .... .55
☐ Resist-O-Meter (A vernier Rheo) 1.80
☐ Jacks, single, open or closed (Firth) .... .35
☐ Jacks, double, closed (Firth) .... .50
☐ Plugs, bulldog grip (Firth) 1.00
☐ .002 and .005 Mica-Bakelite Condensers .... .25
☐ .0005 and .00025 Condensers with Var. Leak .... .25
☐ .0005 and .001 Fixed Mica-Bakelite Condensers .20

BRILLIANTONE RADIO PRODUCTS
Dept. C, 874 Columbus Avenue, New York

Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

Name ....

Address ....

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EISEMANN

The Building of Radio Sets Simplified

THE enjoyment which every Radio Fan derives in constructing his own receiving set is due, in a large measure, to the feeling that a practical knowledge of Radio is in this way acquired. Naturally, a more thorough understanding of the subject is obtained. It does not, of necessity, follow that the assembly of a receiving set must involve tedious labor.

Heretofore, little consideration has been given, in the design of radio parts, to their adaptability for use by the individual who does not possess an elaborate set of tools. The necessity for the use of panels of insulating material; the lack of provision for mounting the different units, and the possibility of improper wiring have all contributed to making the assembly of a receiving set a laborious undertaking.

In Eisemann Radio Parts and Panels a combination of excellence of electrical characteristics and provision for ready assembly is found.

Aluminum panels, in four stock sizes, with uniform size openings permit interchangeable mounting of Eisemann Parts. All drilling of holes is eliminated, and the use of shielding made unnecessary. Proper spacing of units—a most important factor—is assured. Binding posts, properly located on each unit, give positive connections and obviate the necessity for cross-leads.

The concave dials and bar control, a distinguishing feature of Eisemann Parts, present a most attractive appearance when mounted on the Aluminum Panels, which have a crystal black enamel finish.

The building of a finished receiving set, without turning the home into a work-shop, is made possible.

Send for Descriptive Literature

EISEMANN MAGNETO CORPORATION
William N. Shaw, *President*
BROOKLYN, N. Y.
DETROIT CHICAGO

BURGESS
RADIO BATTERIES

—*ARE RECOMMENDED by leading manufacturers of radio equipment.*

—*ARE SPECIFIED by radio engineers.*

—*ARE DESIGNED and built by radio engineers.*

—*ARE A GUARANTEE of satisfactory service.*

—*ASK ANY RADIO ENGINEER.*

Burgess Radio Batteries are handled by all progressive jobbers and dealers. Look for the distinctive black and white stripes. If your dealer doesn't handle the Burgess line just address the nearest Burgess office below.

BURGESS No. 6 BATTERIES

are highly recommended for use in "A" or filament circuits where one and one-half volt Vacuum Tubes are used.

BURGESS BATTERY CO.
Engineers—Dry Batteries—Manufacturers
FLASHLIGHT—RADIO—IGNITION—TELEPHONE

General Sales Office: Harris Trust Bldg., Chicago
Laboratories and Works: Madison, Wisconsin
BRANCHES:
NEW YORK BOSTON WASHINGTON
ST. PAUL KANSAS CITY NEW ORLEANS

In Canada: BURGESS BATTERIES, Ltd.
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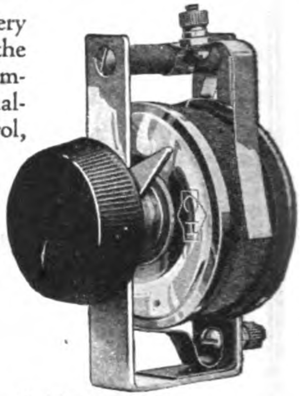
"ASK ANY RADIO ENGINEER"

BURGESS
RADIO BATTERIES

Increase Your Range



This new "A" Battery Potentiometer by the engineers of Cutler-Hammer, world-known specialists in rheostatic control, will bring new stations to your receiving set, and give you increased signal strength for better reception.

It is correctly designed for maximum service—with a resistance unit that cannot be displaced under constant usage. Demand the C-H trademark—*it is your guarantee of satisfaction.*

Resistance 300 ohms.
Panel Mounting. Pointer Indicating. Adjustable Contact Fingers. Genuine Thermoplax Knob Convenient Binding Posts for easy wiring. Finished in dull satin nickel.
Type 11602 .... $1.50

THE CUTLER-HAMMER MFG. CO.
Member Radio Section, Associated Manufacturers of Electrical Supplies
MILWAUKEE - WISCONSIN

Over a Quarter Million C-H Radio Rheostats Now in Use

C-H RADIO "A" BATTERY
POTENTIOMETER

BLOW YOURSELF
To one and solder the connections on your Radio set. Fine for close, careful work. Produces a 1400° needle-point flame instantly. Just the tool for fixing the wiring on your car, repairing electric fixtures, mending kitchen utensils. Used by electricians and mechanics everywhere.

Lenk Super, 75c

60" coil self-fluxing (acid or rosin core) solder	25c
Lenk "Jumbo" (Mouth Blow) Torch	$1.00
Lenk Automatic (blows itself) Torch	$1.50
Marvel Soldering Kit—one Lenk Automatic and one coil each of self-fluxing acid and rosin core solder, in neat leatherette case	$2.00

If your local dealer cannot supply you, order direct.
LENK MFG. CO., 40 Portland St., BOSTON, MASS.

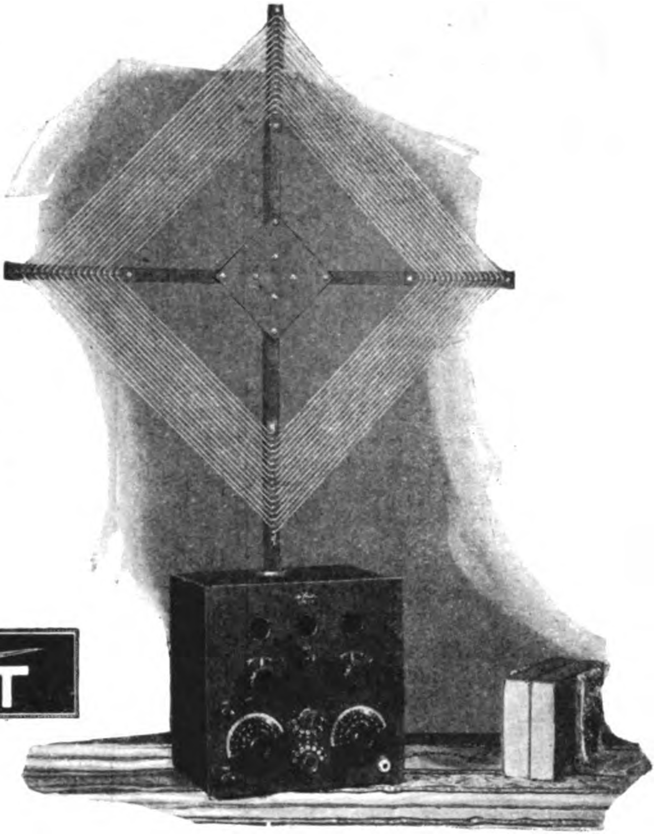
THIS De Forest D-7 Reflex Radiophone* is the famous receiver which has been attracting nation-wide attention by receiving half the Continent on an indoor loop aerial, under most adverse receiving conditions. It is notable for the elimination of extraneous noises and the absence of distortion, and its single-knob control makes it particularly easy to operate. This is probably the most compact, beautiful, and highly selective receiving set in existence. De Forest dealers carry both De Forest and Radio Craft sets.

De Forest Radio Tel. & Tel. Co.
Jersey City, N. J.

DE FOREST

"His Daddy's Choice"

*Reg.
U. S. Pat. Off.



HERE'S the regenerative receiver that has worked a transformation in many a home! Radio Craft's D-4 offers the long-distance reception of the regenerative circuit, and the D-5 2-step amplifier actuates a loud speaker so that the whole room can enjoy the broadcast. When you add to the regenerative principle the long tested reliability of the De Forest parts of which these sets are made, you get a combination which at a low price touches the high spot in present-day radio.

RadioCraft

"His Daddy's Choice"

The
RadioCraft Co., Inc.
139 Franklin St.
Jersey City, N. J.

faultless!

Bakelite-Dilecto (xx grade) is 100% perfect for radio panels. Insist on it!

Better than plain fibre because it resists water, solvents and acids.

Better than hard rubber because it resists heat, high-voltage ozone and fumes, and is more durable.

bakelite-dilecto!

(A Laminated Phenolic Condensation Product)

Better than wood because it is tougher and harder, does not swell, warp or crack, and is non-inflammable.

Your electrical dealer will get it machined for you.

THE CONTINENTAL FIBRE CO.
FACTORY: NEWARK, DELAWARE

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New York .... 233 Broadway
Pittsburgh .... 301 Fifth Ave.
Chicago .... 332 S. Michigan Ave.
San Francisco .... 75 Fremont St.
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XX

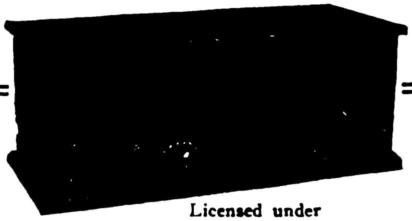
Have we received your order for the 1923 Ace Radio Broadcast Receiver?

If not, you still have an opportunity to get immediate delivery if you place your order NOW!

Let us send you our booklet, "Radio in your home."

Address Dept. XM

THE PRECISION EQUIPMENT CO.
POWEL CROSLEY, Jr. *President*
2437 Gilbert Avenue Cincinnati, Ohio



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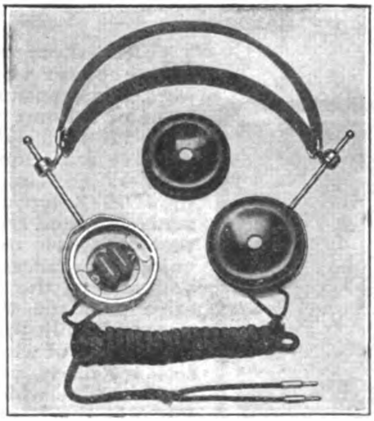
RADIO

HEADPHONES



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$8 LIST PRICE $8

2,200 OHMS LOUD AND
LIGHT WEIGHT CLEAR

Dealers May Send
$3.20 for Sample

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You can market the hours you are free and get cash for them. You will be well paid for the few afternoons or evenings each week it takes you to tell your friends about POPULAR RADIO. No experience is necessary. The work is pleasant and profitable. Let us tell you all about it. You will be under no obligations to us if you *clip this coupon and mail it today*

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Please tell me how I can make money in my spare time by acting as your subscription representative.

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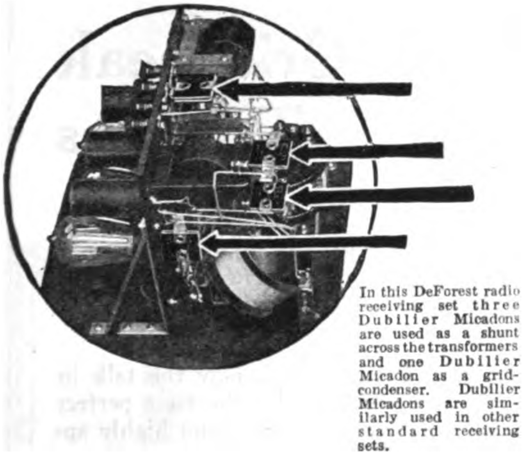


In this DeForest radio receiving set three Dubilier Micadons are used as a shunt across the transformers and one Dubilier Micadon as a grid-condenser. Dubilier Micadons are similarly used in other standard receiving sets.

Why Dubilier Micadons *are used in De Forest Sets*

PERFORMANCE (and therefore the reputation of a radio manufacturer) is so dependent on good condensers that in De Forest radio receiving sets and in others equally well known, Dubilier Micadons are the standard equipment.

Unless a radio receiver is fitted with Dubilier Micadons the broadcasting station is not heard at its best.

The list price of Dubilier Micadons varies from 35c to $1.50 each, depending on the capacity.

Send for descriptive circular.

DUBILIER CONDENSER AND
RADIO CORPORATION
48-50 West Fourth St., New York

BRANCH OFFICES

San Francisco, Cal., 709 Mission St.
Washington, D. C., Munsey Building
St. Louis, Mo., Syndicate Trust Bldg.
Chicago, Ill., 33 So. Clinton St.
Atlanta, Ga., Forsyth Building
Seattle, Wash., 1926 L. C. Smith Bldg.
Pittsburgh, Pa., 704 Granite Bldg.
Los Angeles, Cal., 337 South Western Ave.
Huntington, W. Va., 1028 Fourth Avenue

Distributed in Canada by General Electric Company, Ltd., Toronto

Brandes

AT least half the interest of radio reception is in catching signals, the human voice, news and music from far-distant points.

Even this is made more interesting when the two receivers in the headset are matched in tone and thus made to speak exactly alike. For this reason Brandes *Matched Tone* Headsets excel. They are more sensitive; also more durable, more comfortable. Ask your dealer for a Brandes *Matched Tone* Headset *if you want the best results.*

¶ Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

District Offices:

76 Pearl Street, Boston, Mass.
709 Mission Street, San Francisco, Cal.
Munsey Building, Washington, D. C.
802 Forsyth Building, Atlanta, Ga.
33 South Clinton Street, Chicago, Ill.
1220 Nicollet Avenue, Minneapolis, Minn.
704 Granite Building, Pittsburgh, Pa.
1028 Fourth Avenue, Huntington, W. Va.

Distributors in Australia and New Zealand:
International Electric Co., Wellington, N. Z.

Made in Canada and England by
Canadian Brandes, Limited, Toronto and London
Distributed in Canada by Perkins Electric, Limited
Toronto — MONTREAL — Winnipeg

C.Brandes, INC.—237 Lafayette St. N.Y.C

Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

Dept. P.R.

The Plunger Ends All Grid Leak Troubles

ACTUAL SIZE

No more shopping around for grid leaks, hoping you'll get the right one for *your* set. Here's a new patented High Resistance that does the trick for *any* set. For the movable plunger permits quick, easy adjustment and to any range, and once set, your grid leak problem is settled for good.

This new invention—the Durham Variable High Resistance—is now the talk in radio circles. There is no other grid leak that can begin to give the same perfect service. Thoroughly tested and highly approved by leading Radio experts. Ask your dealer for it. If he hasn't it, send 75 cents for each one wanted, and we will supply you direct. Full description on request.

Durham
Variable
High Resistance

Fits standard clip base. Durham base 40c extra. When ordering give range desired. No. 100 is variable from 1,000 to 100,000 ohms; No. 101 from 100,000 ohms to 5 megohms.

DURHAM & COMPANY
Radio Engineers
1936 Market Street, Philadelphia

ELECTRICAL men with training are in demand. For more than a quarter of a century, this school has been training men of ambition and limited time, for the electrical industries. Condensed course in Electrical **ENGINEERING** enables graduates to secure good positions and promotions. Theoretical and Practical Electricity, Mathematics, Steam and Gas Engines, Mechanical Drawing. Students construct dynamos, install wiring and test electrical machinery. Course with diploma, complete **IN ONE YEAR**

Thoroughly equipped fireproof dormitories, dining hall, laboratories, shops. Over 3000 men trained.

Write for catalog. 30th year opened Sept. 27th, 1922.

BLISS ELECTRICAL SCHOOL
128 TAKOMA AVENUE, WASHINGTON, D. C.

If Making Your Own Radio

This New Handy Time Saver Disc of screw threads and tap drill sizes will automatically give the correct size of drill to be used when using any kind of a tap. The tap drill sizes for U. S. Standard screws; S. A. E. Standard; tap drill sizes for all pipe taps also tap drill and body drill sizes for machine screws used on radio work together with a complete table of decimal equivalents by sixty-fourths of an inch.

Printed on the very best pressed fibre size 3¼ inches with printed instructions. Two for 25 cents postpaid. Stamps accepted.

HAN—DISC COMPANY—3101 Lyndale S., Minneapolis, Minn.

DUCK Radio Pioneer Announces Startling Reductions

Leading Line Since 1909 At Prices to You Less Than Dealers' Cost

FREE Illustrated pamphlet comprising sixty-two Duck radio instruments and sets with reductions averaging 30% mailed on request. Send postal today. Any old-time radio amateur will tell you who we are and our reputation. Only a few years ago almost one-third of the radio instruments sold at retail, exclusive of sales in only a half dozen large cities, were sold by Duck.

A Few of the Many Duck Products at Sensational Prices:

Rheostat, 70c; Bakelite moulded positive contact, 70c; Bakelite Moulded Dial, 55c; superselective moulded variometer, $4.65, worth $8.00; radio frequency potentiometer, $1.15; solid mahogany form variometer, $3.60; 43-plate panel-type variable condenser, pigtail connection, $3.15; detector panel, $5.25; receiving set, mahogany cabinet, detector and two stages of audio frequency, $59.50; radio frequency receiving set with one-step radio and detector, $29.75.

SEND 25c in coin or money order for our big 256-page combined radio catalog and text book. For radio information and hook-ups it is worth many times the retainer asked.

THE WILLIAM B. DUCK COMPANY, 227-229 Superior St., Toledo, Ohio

The Ideal Battery

for Low Voltage Tubes

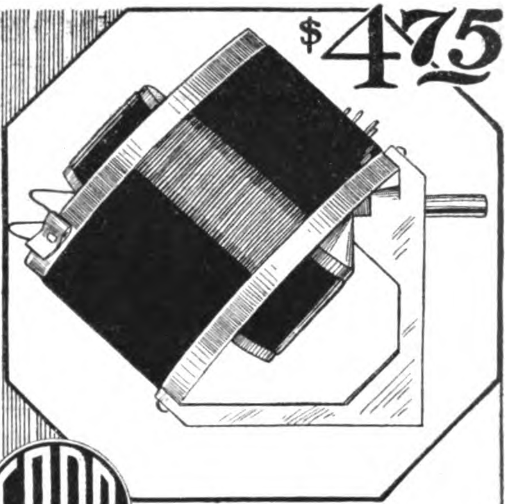
The Storage Battery Magno is ideal for low voltage tubes. It is the most economical battery made—costing much less than dry cells to operate.

The Magno is recharged by unscrewing cover in inserting "spare" electrode. "Spares" are exchangeable at your dealers or direct from our factory. Each spare will give many times more hours of service than will a dry cell. Keep a spare charge on hand and your concert will never be interrupted. Learn more about this remarkable storage battery.

Write today for descriptive folder. Dealers write for lists.

Magno Storage Battery Corp.
Aeolian Bldg., New York City

STORAGE BATTERY
MAGNO

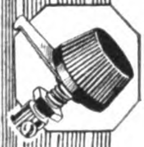


$4.75

FADA

Vario-Coupler

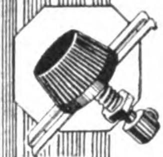
The fastest selling vario-coupler on the market. Technically O. K. and the price is right.



40¢

Inductance Switch

A mighty fine switch. The knob matches Fada Rheostat knob.



55¢

Series-Parallel Switch

Changes quickly from circuit to circuit. The handiest switch for experimenters.

$1.20

Power Rheostat

Will control three or four radio frequency amplifier tubes.

Send 10c for Fada Handbook. Plumb full of radio facts.

F. A. D. ANDREA
1581 D Jerome Ave. N. Y. C.

FADA
RADIO PARTS

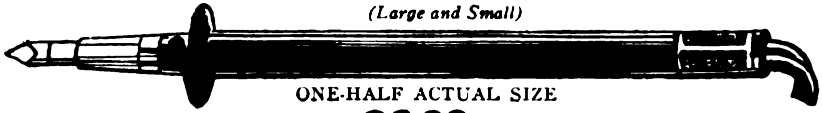
DELICATE SOLDERING

Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tips—Universal Current

(Large and Small)



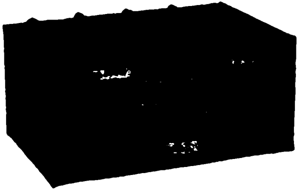
ONE-HALF ACTUAL SIZE

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York



DELFELCO RADIO B BATTERIES

ARE GUARANTEED

Small 22½V	$2.00
Small 45V	4.00
Large 22½V	3.00
Large 45V	5.50

Postage Paid

DELFELCO BATTERY CORP.

11 MEETING STREET PAWTUCKET, R. I.

RUSONITE

CRYSTAL RECTIFIER

MULTIPOINT

(Patent Pending)

A Synthetic CRYSTAL DETECTOR sensitive over its entire surface

Eliminates all detector troubles. Extraordinary clearness and volume. Endorsed by radio experts and press. Sold in sealed packages only. Join the ever-increasing Rusonite fans.

Price, postpaid, mounted Sensitiveness guaranteed 50c

RUSONITE CATWHISKER 14-Karat Gold Multiple contact. Supersensitive 25c

Order from your dealer or direct from us.

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GIVE YOUR EARS A TREAT!—USE

"RED-HEADS"

3000 Ohms

With Military Head-Band and Cord

Now $6.50

At your dealers or direct on receipt of price.

A Triumph in Radio Receiver Design

The Newman-Stern Co. Newman-Stern Building Cleveland, O.

SELF-FILLING INK PENCIL "INDEPENDENT"

Guaranteed Improved Fountain Pen. Eliminates fatigue. Promotes efficiency. Writes uniform. A business necessity.

$2 By Mail

Meets all requirements. Self-filling, non-leakable, safety cap. Attached clip. Smooth writing gold Stylo point. Your name in Gold—25 cents Extra. Agents Wanted.

J. X. ULLRICH & CO., 161 Washington St., New York

WESTERN HOME BATTERY CHARGER

CHARGES your radio Storage Batteries from 110 volt alternating or direct current lighting socket, of any cycle.

Keep your Battery fully charged and receive the maximum-range from your receiving set. Charges Battery over night for a few cents. Has no delicate bulbs to break or burn out; no moving parts of any kind to get out of order; no adjustments to make, and will charge as many as six 6 volt batteries at one time if necessary.

Will also charge Automobile starting and lighting batteries. Shipped anywhere in the United States and Canada for $6.85. Send 25% with order; balance C. O. D. or 2% may be deducted if full cash accompanies order.

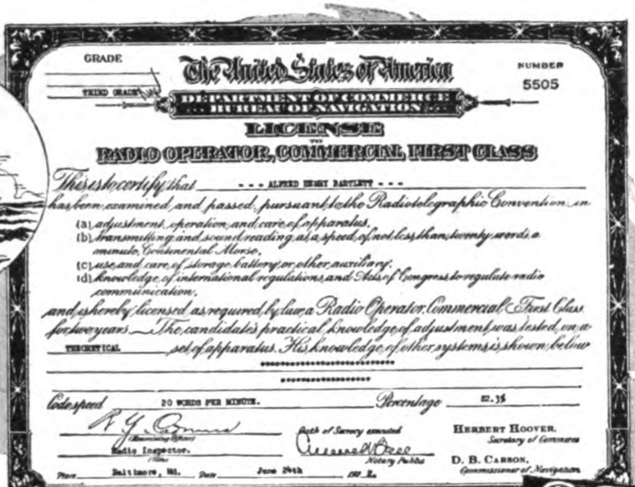
Note:—We have a large quantity of high-grade Radio Storage Batteries of all sizes, which we are selling at bargain prices.

Radio Dealers should send at once for our distributors' proposition. Description of our line of Chargers and Radio Storage Batteries sent upon request.

NOW $6.85

WESTERN RUBBER MOLD & BATTERY COMPANY

321-323 North Crawford Avenue Chicago, Illinois



GRADE

THIRD GRADE

The United States of America

NUMBER 5505

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION

LICENSE
TO
RADIO OPERATOR, COMMERCIAL, FIRST CLASS

This is to certify that - - - ALFRED HENRY BARTLETT - - -
has been examined and passed, pursuant to the Radiotelegraphic Convention, in
(a) adjustment, operation and care of apparatus,
(b) transmitting and sound reading at a speed of not less than twenty words a minute, Continental Morse,
(c) use and care of storage battery or other auxiliary,
(d) knowledge of international regulations and Acts of Congress to regulate radio communication,
and is hereby licensed as required by law a Radio Operator, Commercial, First Class for two years. — The candidate's practical knowledge of adjustment was tested on a THEORETICAL set of apparatus. His knowledge of other systems is shown below

Code speed 20 WORDS PER MINUTE. Percentage 82.3%

(Examining Officer)
Radio Inspector.
(Title)

Oath of Secrecy executed
Notary Public

HERBERT HOOVER,
Secretary of Commerce

D. B. CARSON,
Commissioner of Navigation

Place Baltimore, Md. Date June 24th 192 2.

Get This First Class Radio License

You Can Earn Big Money With It

THE best paid positions in radio go to the men who hold the Government's First-Class Commercial License. The radio men on every ship, in every land commercial station, in every broadcasting station, must have one of these licenses. Every radio inspector must pass the first-class license examinations. Engineers, mechanics, installation and maintenance experts must all of them own a Government First-Class Commercial License. It is every radio man's ambition to get a license, not only because it is the highest mark of honor he can get, but because it also opens to him all the wonderful opportunities in this great profession.

Emmett Welch of Peculiar, Mo., is Radio Salesman making $300 per month and expenses, Merle M. Wetzel is inspector in the Engineering Dept. of a Public Service Co., Edwin Forsyth is on his way to Scotland as first-class licensed operator on board ship. Read in the panel of the fine salaries paid in all the wonderful positions open to you as soon as you get the Government First-Class License.

Pick Out the Job You Want and We Will Help You Get It

We have trained hundreds and helped them to splendid paying positions in Radio. You will be interested in knowing exactly what these graduates are doing and in reading the actual letters written by them. Our new Free Book contains scores of these letters, each one a story of success in itself. Send for this book.

Here is a brief list of positions in Radio, and the salaries they pay.

Radio Mechanics, $1,500 to $2,000 a year.

Radio Inspector, $1,800 to $3,000 a year.

Radio Auditor, $1,200 to $1,800 a year.

Radio Salesman, $2,000 to $5,000 a year.

Radio Engineer, $3,500 a year and up.

Radio Executive, up to $10,000 a year.

Radio Aid, $6 to $10 a day.

Radio Draftsman, $7 to $10 a day.

First Class Ship Operator, $105 a month, all expenses paid.

Commercial Land Station Operator, $150 a month and up.

Broadcasting Station Operator, $125 to $250 a month.

Win Your Government License This New, Easy Way

The National Radio Institute, America's first and largest Radio School, has devised a remarkable new method that makes it easy for you to win your license. No previous experience in electricity or radio is necessary. Spare time study at home prepares you in an amazingly short time to pass the Government examinations, so you can get one of the fine jobs waiting in this great field. The diploma we give you upon completion of the course, counts for 5 to 10 credits on all government license examinations.

Four Radio Instruments Free

An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation and maintenance and repair—all of which you **must** have to become an expert.

Among these instruments is the wonderful Natrometer, said by experts to be the perfect device for teaching the Radio Code. All of these instruments are given free during the course.

Send for Free Radio Book

Thousands of positions are open to Radio Experts. Find out what **your** opportunities are in this fascinating profession. Send for interesting free book, "How to Learn Radio at Home," which gives complete details of plan by which the National Radio Institute quickly qualifies you for a Government Commercial License. If you are sincerely ambitious, send the coupon or a postcard for free book NOW.

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WASHINGTON, D. C.

NATIONAL RADIO INSTITUTE
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Washington, D. C.

Send me your free book, "How to Learn Radio at Home," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Government First-Class Commercial License. Also tell me how your free Employment Service will help me to a position.

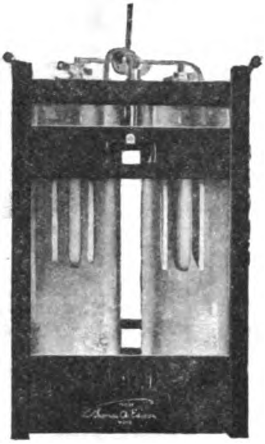
Name.. Age............

Street ....

City.. State............

THE EDISON RADIO PRIMARY BATTERY

FOR WD11 TUBES



This battery, a product of the Edison Laboratories, is designed for the operation of from one to three of these tubes. When used to operate one tube, it will last

1000 HOURS WITHOUT CHARGING

or any other attention. It may then be restored by renewing the elements and solution and will repeat this performance with each renewal.

Inquiries solicited from dealers and jobbers

Price Complete $8

Renewals $3

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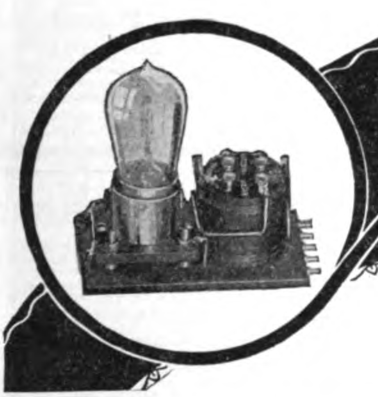

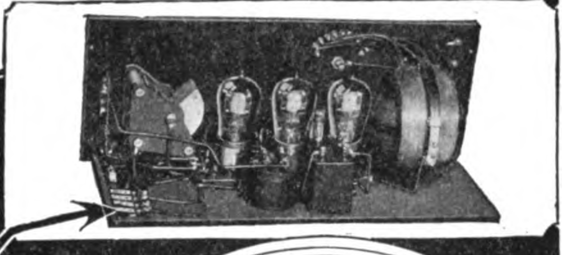

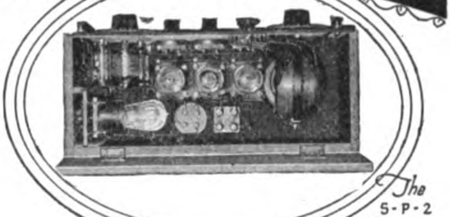

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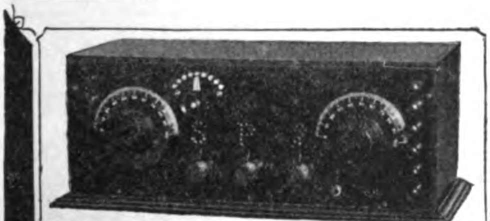

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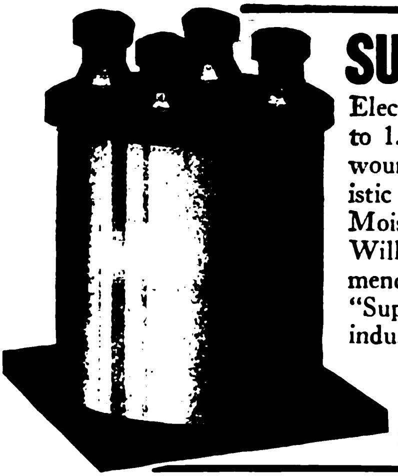

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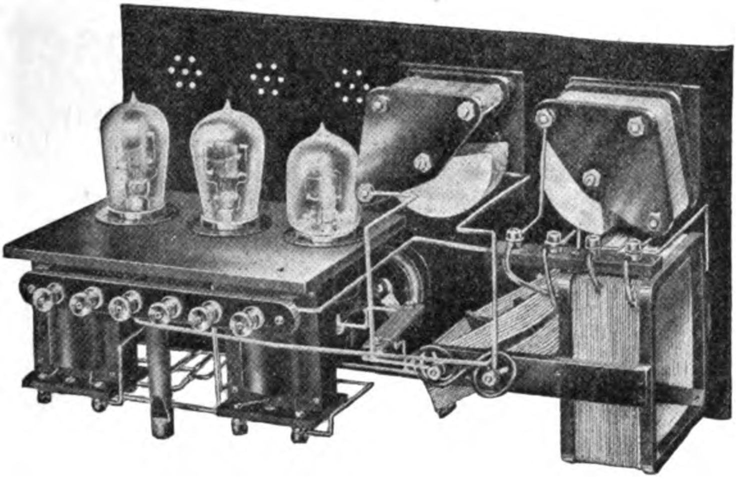

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So there was only one thing to do. We increased the thickness of the magazine! Now there will be no space limitations to prevent getting these articles quickly to our readers. "Month by month POPULAR RADIO is growing bigger and bigger."

The Same POPULAR RADIO
—only more of it!

You'll be tickled with POPULAR RADIO these coming months. The same helpful, practical, interesting articles will continue. There will be more of them. New departments will be added. Don't take a chance on missing any of these bigger, better issues. Become a regular subscriber and get the magazine each month at your home.

Although the price of POPULAR RADIO has already been advanced to 20 cents on the newsstands, you can get a full year's subscription, 12 issues, for only $1.50. But this offer is open for a short time only. Act at once!

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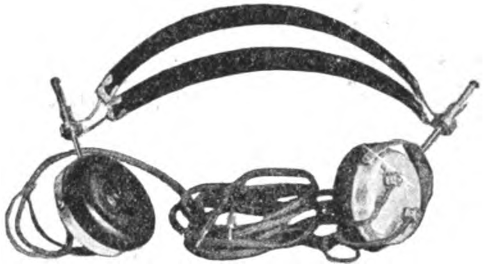

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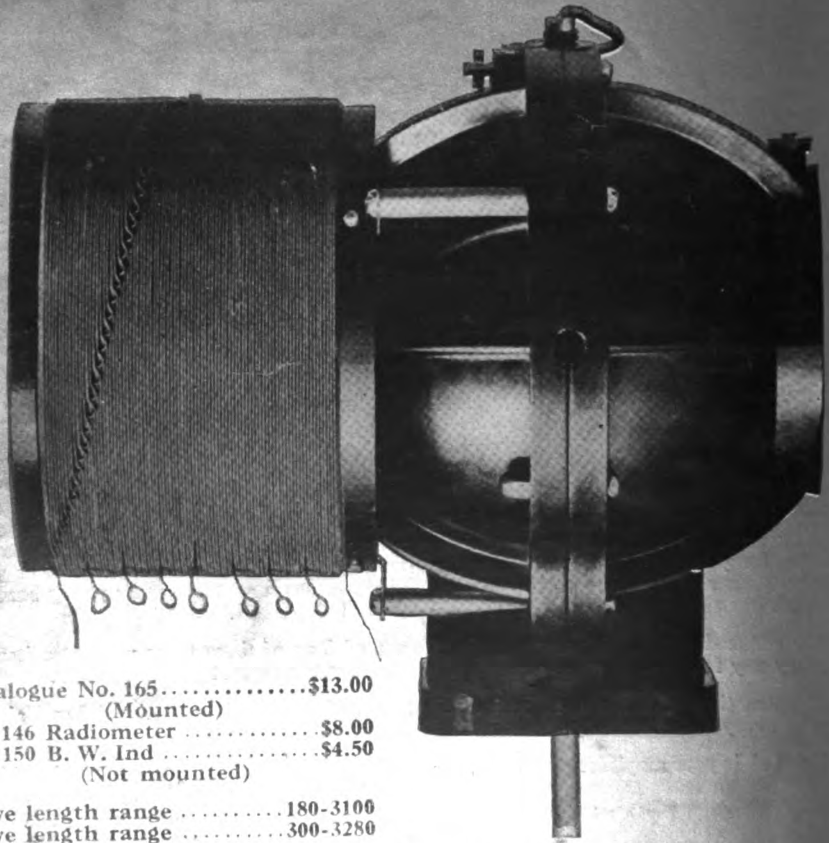

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., ***Contributing Editor*** LAURENCE M. COCKADAY, R.E., ***Technical Editor***

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A PAGE WITH THE EDITOR

WITH this issue POPULAR RADIO authoritatively announces—as it might have unauthoritatively announced some months ago—that it has the "largest certified circulation of any radio magazine."

* * *

POPULAR RADIO has not, up to this time, quoted circulation figures. It has never asked advertisers to accept statements that could not be verified and certified and otherwise established as indisputable facts. Circulation claims that cannot be proven are (to quote the Editor's honored professor of English) "both interesting and convincing—particularly neither."

* * *

"THERE IS need at present for a suitable name for that particular type of broadcasting which is based on wired wireless principles," writes Major-General George O. Squier to the Editor. "Every day sees the necessity for a word which should express as clearly as possible the idea involved and distinguish it carefully from general broadcasting. I have noted that in your excellent journal recently the subject was referred to as narrowcasting. I do not particularly like this word; it is too long and the word 'narrow' implies something limited. Another word which has been suggested here is 'wirecast' or 'wirecasting.' Perhaps you or some of your readers could suggest a suitable term."

In accordance with the General's wishes, the polls are now open for suggestions. Write and tell us what term should be used.

* * *

THE extending use of POPULAR RADIO in the schools and colleges is perhaps the most convincing proof of the regard in which the magazine is held that the Editor could ask. Principal John H. Frizzell of the High School for Boys in Reading, Pa., for example, recently "experimented" with the magazine by having it come to the school so that he could know "whether or not it would be a good plan" to subscribe to it regularly.

Two months later he reported: "The experiment is a decided success. The magazines are worn out before the month is half up, and not from carelessness in handling, but from reading. The boys like it. It has gone 'over the top' with a bang."

* * *

THE rapidly extending recognition given to the articles in POPULAR RADIO by governmental authorities and scientists generally furnishes impressive evidence of the standing that this magazine enjoys. The *Radio Service Bulletin* (for example) issued by the Department of Commerce on January 2, lists no less than six articles in our January number alone as "among the more important papers of interest to the professional radio engineer which have recently appeared in technical periodicals."

AMONG the radio experts who have been called in by our Technical Editor to help handle the mass of questions from our readers is Russel P. May, widely known among navy men as the radio engineer who planned and designed ship, shore and aircraft installations for the Navy Department during the war. He is the inventor of the push-pull oscillator circuit, and was formerly an associate of Dr. De Forest in the development of the original Cascade amplifier; he also assisted in the development of Dr. De Forest's first high-frequency-spark telephone, the forerunner of the modern radio telephone.

Our readers may be assured that their problems have been worked out by a Man Who Knows.

* * *

"MY boys think that there is no paper that compares with POPULAR RADIO in helping them to make their wireless outfits. At the present time we have five separate sets in our house."

So writes Frank B. Gilbreth, the well-known industrial engineer and authority on scientific management. And he backs up his opinion with a check for another subscription.

* * *

THE Editor's appeal to our readers to dispose of such of their radio parts as they no longer need to the hospitals for veterans has not been in vain. The latest call comes from U. S. Veterans Hospital No. 78, in North Little Rock, Arkansas. "Our aerial is already up," writes Nurse Pauline Peters. "Now we want a receiving set to entertain our boys."

What Good Sport among our readers will help out—at least to the extent of sending along some useful parts?

* * *

EACH day brings additional evidence of the esteem in which POPULAR RADIO is held abroad; so many eminent European scientists are now numbered among our contributors that the magazine is assuming an international character. "I can assure you that we have no wireless magazine in England equal to it," writes Mr. John Scott of Newcastle-upon-Tyne—and, properly enough, he encloses a subscription in proof of his conviction.

* * *

"THE magazine with the silver cover" is literally being swept off the newsstands! The only way to be sure of getting your copy is to subscribe.

* * *

LAST call for subscriptions at the present rate of $1.50 a year! Beginning March 20th the yearly subscription will be $2.00.

Kendall Banning

Editor, POPULAR RADIO

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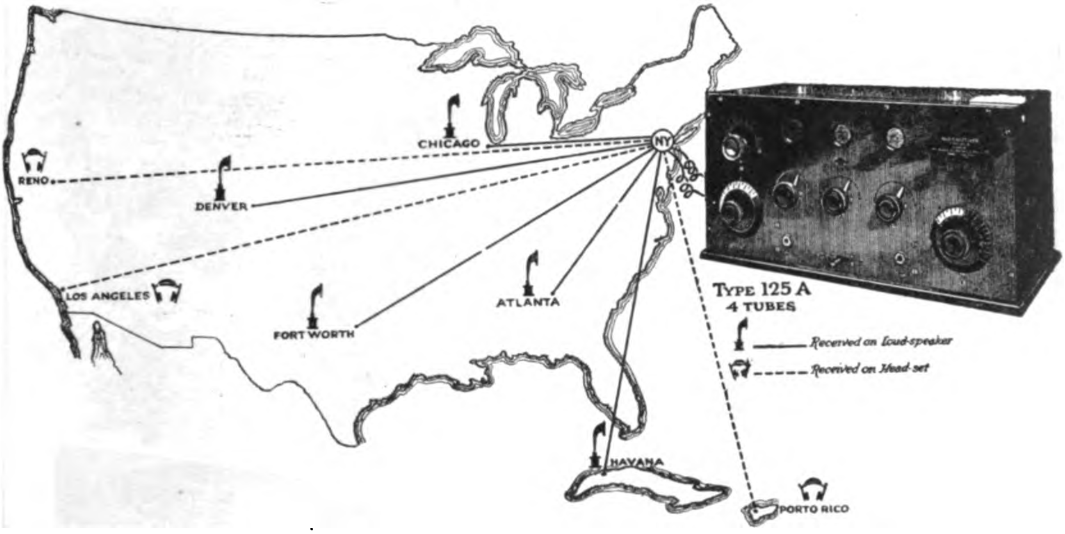

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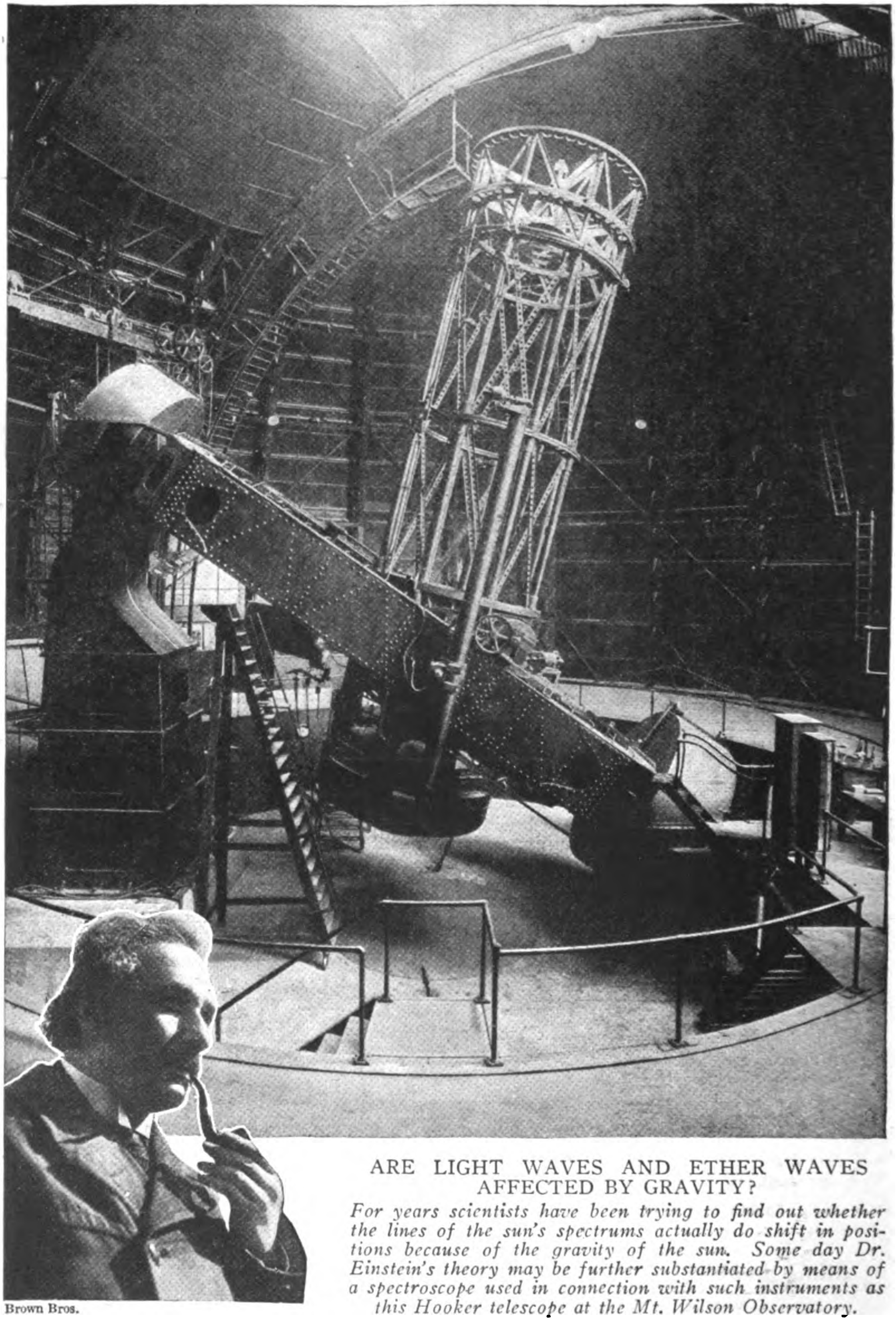
To the Editor of Popular Radio:

I have followed with more interest than you know your work to utilize radio broadcasting for the common happiness and education of the country. Your plan of action seems to me to be sound sense and a real vision of service. My congratulations to you. And here's our pledge to help you in every way we can.

John G. Bowman

Chancellor, University of Pittsburgh



Brown Bros.

ARE LIGHT WAVES AND ETHER WAVES AFFECTED BY GRAVITY?

For years scientists have been trying to find out whether the lines of the sun's spectrums actually do shift in positions because of the gravity of the sun. Some day Dr. Einstein's theory may be further substantiated by means of a spectroscope used in connection with such instruments as this Hooker telescope at the Mt. Wilson Observatory.

Popular Radio

VOLUME III APRIL, 1923 NUMBER 4

RADIO *and* RELATIVITY

An Explanation of Ether Waves in the Light of the Einstein Theory

FOREWORD

The now famous article, *There Are No Ether Waves*, by Dr. Charles P. Steinmetz (published in our issue for last July), precipitated an international discussion which is still keeping the scientists stirred up. As a result POPULAR RADIO has received so many inquiries concerning the exact relation of the Einstein theory to the problem of ether waves and radio that we asked Dr. Free to prepare this outline of the theory in terms that the lay reader can understand.—EDITOR.

BY E. E. FREE, Ph.D.

JUST why does the Einstein theory prove so difficult to understand?

I think it is because most of us begin to study the theory in a wrong way. We begin by trying to make a *picture* of what Einstein means.

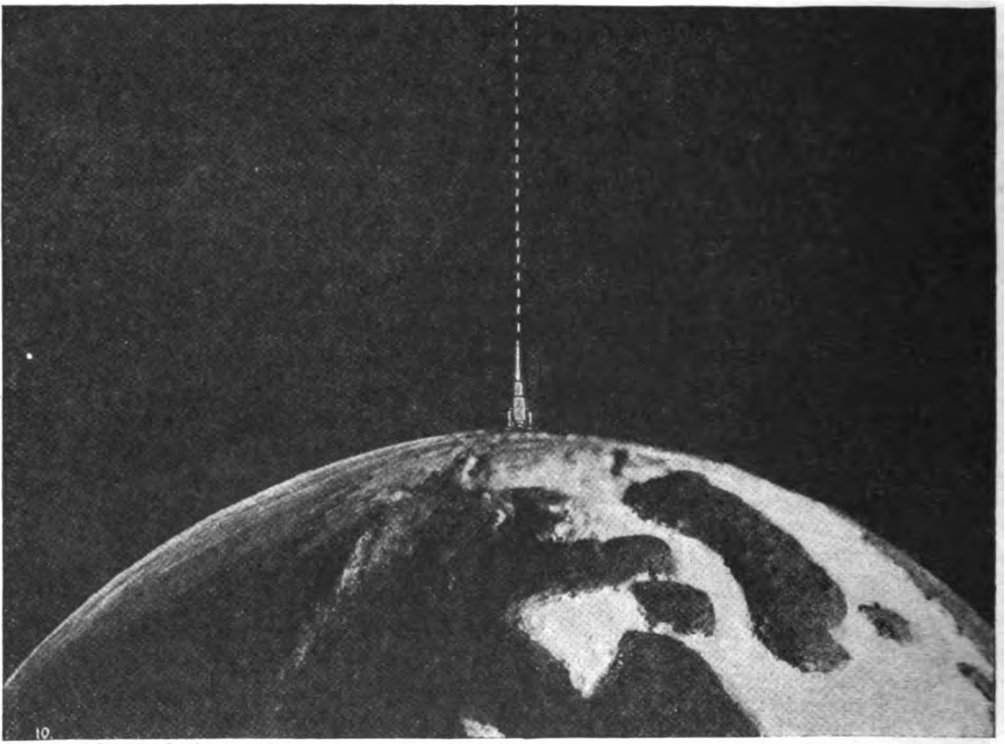
We have grown accustomed to this way of understanding things, by what we call "visualizing" them. For instance, we get an idea of the character of the solar system by making a mental picture of it, a picture of a lot of round balls for planets revolving about a larger ball for the sun.

We understand radio similarly, by pictures of waves in the ether or of electrons flying about inside the vacuum tube. Most of the science of physics consists of such mental pictures of things.

Now it is a law of the mind that all such pictures are built up out of experience, out of things which we have actually seen. We could have no mental picture of the solar system unless we had sometime seen round things like oranges or billiard balls, and had seen things in rotation about a center like the rubber balls that boys whirl on the end of strings.

The peculiar difficulty of understanding the Einstein theory is due mainly to the fact that we cannot apply to it this customary process of making mental pictures.

Imagine an artist so insistently devoted to the principles of cubist art as to have banished from his house everything that was round. Suppose that no balls or apples or round lamp globes were allowed, and that even the door knobs were square. And imagine a child



Courtesy of Premier Productions, Inc.

How the Course of a Cannon Ball Looks to a Person on Earth

To an observer on our globe and traveling with it the path of the projectile fired perpendicularly appears to be straight up and down.

brought up in this rectangular house; a child who had never been allowed to see a sphere, a child from whom all experience of roundness had been kept.

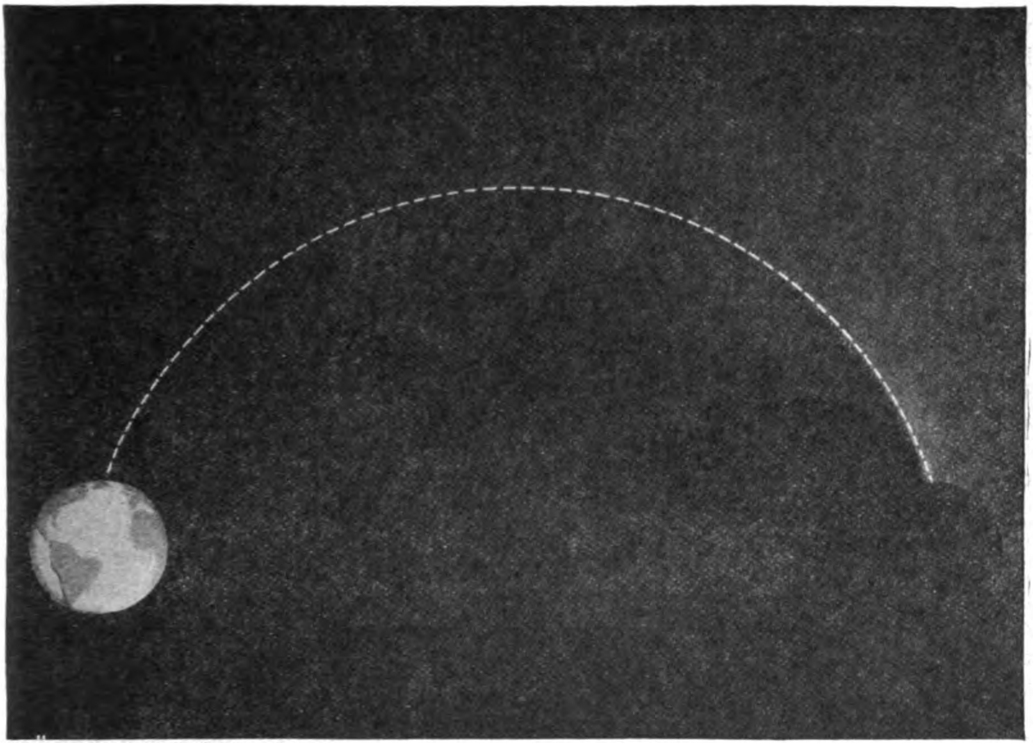
This child would not be able to understand the solar system as we do. He would not know what a round ball was nor what it was like. He could form no picture of the planets. The customary descriptions would be, for him, mere meaningless words.

So when we ordinary people approach the Einstein theory we are in exactly the mental situation of this cubist child. We have never seen the things that Einstein talks about or anything like them. So far as we know we can never see them. It is utterly impossible for us to make any kind of a picture of them; either a picture on paper or a model or an image in our mind's eye. **The theory cannot be visualized at all.**

Does this mean, then, that the understanding of the theory is impossible?

Not a bit of it. It means merely that we cannot understand it by trying to make pictures of it. But this way of understanding things, while the most common way, and for most people the easiest way, is not the only way. You have, for instance, a fairly good idea of honesty. You know it when you encounter it. You understand it at least as well, probably, as you understand the solar system. Yet you cannot make a picture of honesty. You cannot visualize it. It is quite possible, you perceive, to understand something which is not picturable.

And so the first thing that I ask you to do, before we even begin to talk about the Einstein theory is to give up trying to picture it. Simply try to *understand* it through the medium of words, just as



Courtesy of Premier Productions, Inc.

—and How the Same Thing Looks to a Person Located off in Space

But to an observer on another planet, the projectile's path appears to be curved; the missile returns to the earth, which in itself has traveled.

you would understand honesty or any other non-picturable idea.

I shall try to explain the theory in the English language. By expressing the ideas of the theory in mathematical symbols (which are, of course, no more than a special sort of language) the expert mathematicians use and work over and modify these ideas with a precision far greater than we can attain in ordinary words. You must bear this in mind; if you want to know *all* about the theory you must study it in its native language of mathematics. So in this description of the theory, I want you to remember:

First, that you are not to try to make mental pictures of it;

Second, that the proper language for all this is the symbols of mathematics.

The first form of the Einstein theory, published in 1905, was an attempt to explain an experiment which has since become famous as the Michelson-Morley experiment. This experiment was devised to detect the motion of the earth relative to the ether. The ether, you remember, was supposed to fill all space, even the space inside masses of matter. It was supposed that the earth passes through it and that it passes through the earth. This last is not so difficult a thing as one might think, for we know that matter is composed of very tiny particles which are relatively quite far apart. Matter has plenty of holes in it, although very small ones, and the ether was thought of as blowing freely through these holes.

A great wind of ether, men thought there was, blowing through all terrestrial matter as the earth swept along in its path around the sun. Michelson and Morley set out to measure this wind.

The ether is, of course, the medium

which carries light. Michelson and Morley set up two mirrors on a great slab of stone and arranged to measure with great accuracy the time required for light to pass back and forth between the two mirrors. This time would be a little different, they thought, when the light was passing parallel to the wind of ether than when it was passing across the wind. The stone slab which held the mirrors was movable. It could be turned so that the mirrors stood first from east to west and then from north to south. Michelson and Morley expected to find that light would pass a little faster in one of the two directions, just as the sound of a shout will travel faster with a gale than across it.

But they did *not* find this difference.

Very surprisingly, the time of passage of light between the two mirrors was always exactly the same, no matter in what direction the stone slab was turned.

This result puzzled the physicists greatly, and many people began to doubt the real existence of the wind of ether which everybody had previously assumed. That is, they began to doubt if space really was full of this something called ether through which the earth was supposed to be sweeping along.

Einstein began to doubt it in a rather special way. He began to doubt the reality of space itself!

The reason for doubting this I can express in no better way than by quoting the great French physicist, Poincaré. He writes:

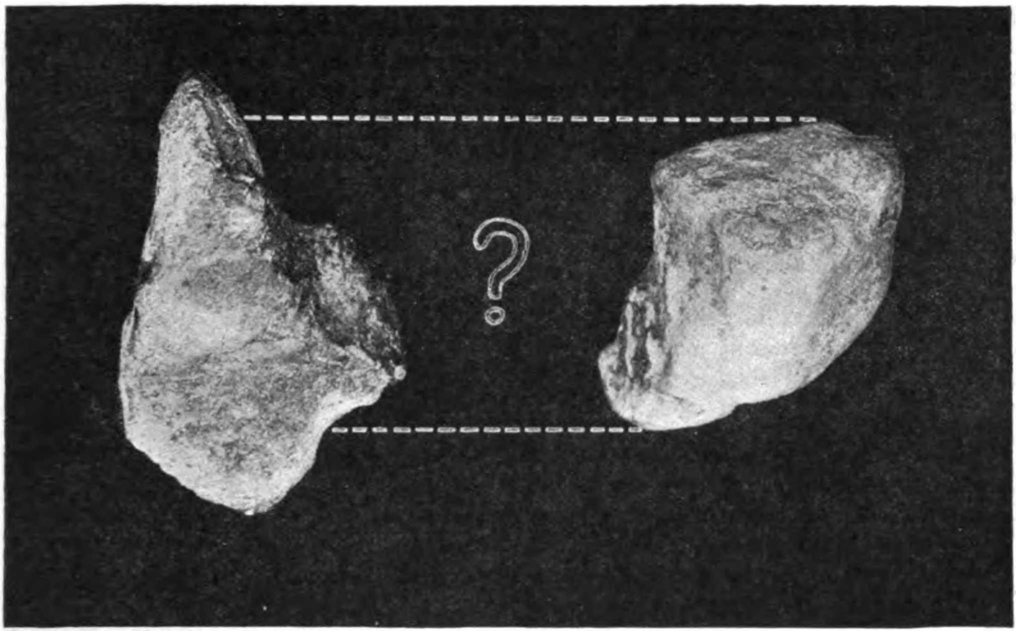
> I am at a particular spot in Paris—the Place de Panthéon, let us suppose—and I say, "I will come back here tomorrow." If anyone asks me whether I mean I will return to the same point in space, I am tempted to reply "yes." But I should be wrong, because between this moment and tomorrow the earth will have traveled, taking the Place de Panthéon with it, so that tomorrow the earth will be more than two million kilometers away from where it is now. And it would be useless attempting to use precise language, because these two million kilometers are part of the earth's journey around the sun, but the sun itself has moved in relation to the Milky Way, and the Milky Way, in turn, is doubtless moving with a speed which we cannot learn. Thus we are entirely ignorant, and always will be ignorant, as to how far the Place de Panthéon shifts in position in space in a single day. What I really meant to say was: "Tomorrow I shall again see the dome and façade of the Panthéon." If there were no Panthéon, there would be no meaning in my words, and space would disappear."

And this, says Einstein, is exactly what space does do. It disappears. Motion, displacement in space, has no meaning unless it be displacement relative to something else. A train cannot merely move ten miles. It moves ten miles *relative to the earth's surface,* or relative to some other predetermined point. All motion, says Einstein, is relative. That is why they call his theory the theory of "relativity."

Einstein began, you remember, with this doubt of the correctness of our notions of space, a doubt induced by the failure of the Michelson-Morley experiment to find evidence of the supposed wind of ether blowing through the matter of the earth. His next step was to see whether he could find anything to substitute for the idea of space, some other fundamental standpoint from which to build up a picture, or, as he said, a mathematical description, of the universe.

He tried the velocity of light. Michelson and Morley had found, you remember, that the velocity of light between their two mirrors was always the same regardless of the direction in which these mirrors stood. Other experimenters had tried other experiments and everyone had found that the velocity of light in a vacuum, that is when not retarded by matter, was always the same. So Einstein decided to *assume* that this was a general law; the law, namely, that the velocity of light in empty space is always the same, the speed of 186,326 miles a second, which we find experimentally that it has on earth.

Having assumed this and having expressed it in the language of mathematics, Einstein proceeded to deduce from it a set of mathematical expressions for the laws of motion of the planets and for



From a photograph made for POPULAR RADIO

ARE THERE TWO ROCKS HERE, OR ONLY ONE?

If time and space are eliminated, as the Einstein theorists point out as a possibility, only an "undulatory continuum" lies between two objects in space, and the two objects thus become merely a part of a great unit.

various other laws of physics. This gave him his first theory of relativity, the one now usually called the "Special Theory of Relativity." It is the one that was published in 1905.

It is important to realize just what Einstein had done. He had found men with a certain picture of the universe, expressed in the main, in mathematical laws of which Newton's laws of motion were typical. This picture and these laws were based upon an assumption, the assumption that things exist inside a kind of ether-filled box which men call space. Poincaré and a few others had already perceived that this assumption was not valid; that the idea of space was meaningless apart from the idea of matter, of things inside space to mark it off. The Michelson-Morley experiment was also against any such idea.

So Einstein said:

Let us throw this outworn assumption away. Let us dispense altogether with the idea of space and try to build up a new and better picture of the universe, a new and better set of physical laws for it. Let us start from a new assumption, one which we have better reason to believe valid.

The new assumption which he selected was the assumption that the speed of light is the same everywhere.

So far so good, but physicists began at once to ask themselves another question. Why stop here? they said; if the idea of space was mistaken, may not the idea of the constant speed of light be mistaken also? All that we actually know is that the speed of light is constant here on earth. Who can say what it may be somewhere else in the universe?

The Einstein theory of 1905 rested on only one assumption, but even that, the physicists said, was one too many. Could not a way be found to construct a mathematical description of the universe without making any assumptions whatsoever?

Einstein thought that such a way might

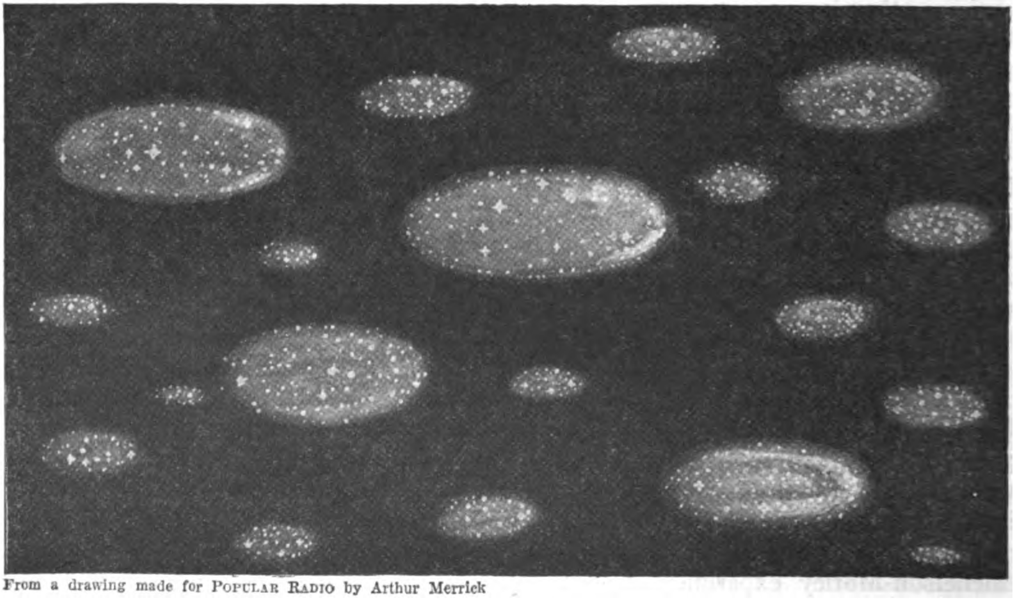
be found and he set himself to the problem. A partial solution appeared in 1911, the final theory in 1915. This is the theory now known as the "General Theory of Relativity."

It is, as I have warned you, purely mathematical. It begins by finding a mathematical expression for motion; an expression which makes use of no assumptions at all, neither the old-time assumption of space nor the assumption of constant light velocity nor any other assumption. From this expression for simple motion, Einstein constructs all over again the mathematical picture of the universe which he destroyed when he showed that the former pictures were based on fragile assumptions.

To the ordinary man, however, the most interesting features of the theory are its consequences. What does it help us to learn about the ultimate nature of things?

The consequences are derived mathematically. If you know the mathematical law of falling bodies you can calculate easily the time required for a stone to fall from the top of the Washington Monument to the ground. Similarly, if you know mathematical laws of the universe, worked out by Einstein and if you can handle the mathematics involved, you can deduce various things which must happen if the theory is true.

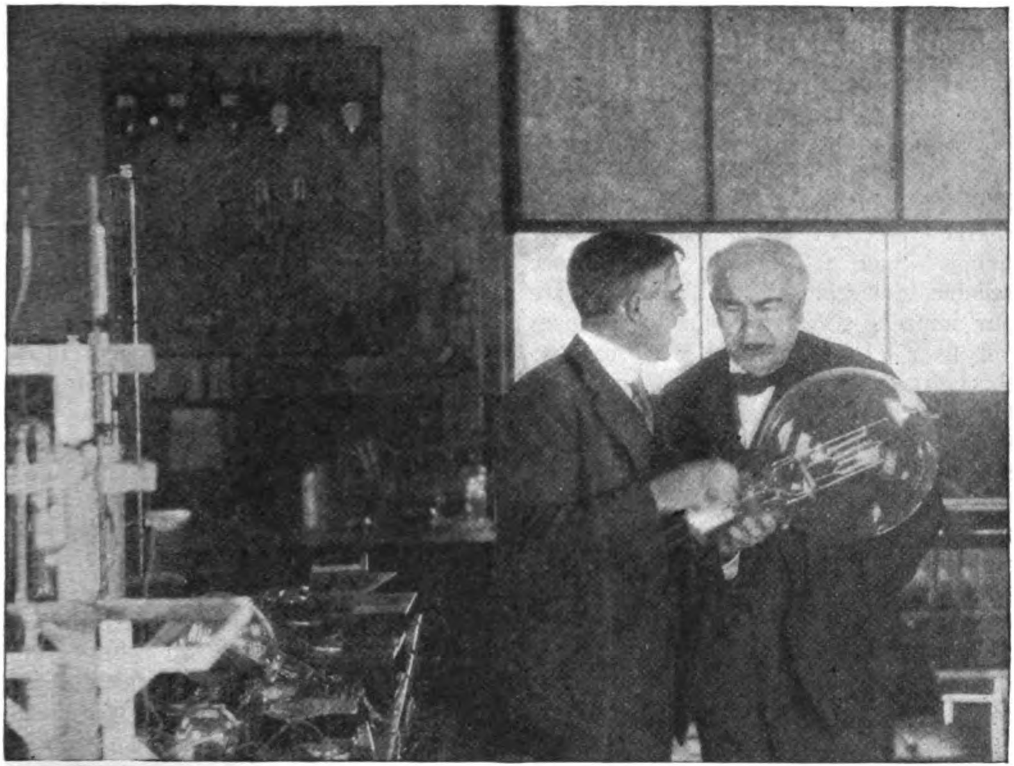
One of these deductions is the thing which first called public attention to the theory. It is the slight shift in the apparent position of stars during a solar eclipse. A ray of light coming from a star and passing very near to the sun does not pass by it, the Einstein theory says, in a perfectly straight line. Instead the light is bent a little so that the star will seem to be moved a trifle from its real position in the sky. When the sun is shining this cannot be observed. The sunlight drowns out the star altogether. But during an eclipse the stars near the sun can be seen and their positions can be photographed accurately.



From a drawing made for POPULAR RADIO by Arthur Merrick

IS OUR UNIVERSE BUT ONE OF MANY, EACH FOREVER UNKNOWN TO THE OTHERS?

If the Einstein theory is correct, rays of light may curve around the inside of the universe and return to where they started. Perhaps there are many universes, each forever unknown to the others, because there is no ether or other light-carrier in the space between them.



General Electric

HOW MUCH DOES THE LIGHT OF THIS LAMP WEIGH?

Dr. Irving Langmuir is here seen showing to Thomas A. Edison the largest electric lamp ever made; it uses an electrical power amounting to 30,000 watts. The weight of its brilliance, when calculated by the Einstein Theory, is so small that the lamp would have to burn 8,000,000 years to produce one ounce of light!

This was done at the time of the eclipse of May 29, 1919, and the predicted slight shift of the stars was found. It agreed with the mathematical deductions from the Einstein theory. The matter was tested again during the eclipse of last September but the results require long and complicated calculations and have not yet been announced.

Many other consequences can be deduced mathematically from the theory, but they are mainly of interest to the professional scientist. Greater general interest resides on the relativitist's picture of what lies behind science, in his picture of the inmost nature of things.

Since Dr. Einstein's publication of this final theory in 1915, it has been extended importantly by Dr. H. Weyl in Germany and by Professor A. S. Eddington in England. What I am about to say is based not only on Einstein but on these recent generalizations also.

Philosophers have always insisted that we really have no knowledge whatsoever of the inmost nature of things. We know the universe, the earth and the things around us only through our senses, only by means of what we can see and feel and hear. We exchange ideas with other people but such exchanges are also as dependent on our senses. We can communicate only by speech which we must hear or by written words which we must see.

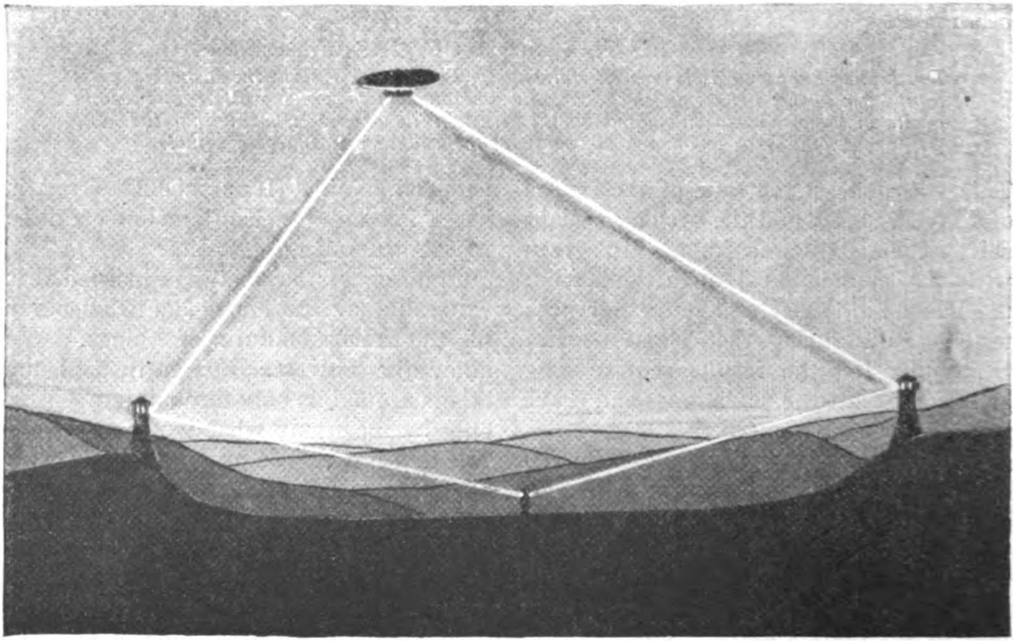
A man born color blind sees the world in a different way from the rest of us. How do we know, say the philosophers, that all of us are not blind in some other way? It is quite possible, they insist, that all human senses are imperfect, that they give us a wrong idea of the real nature of things around us.

According to the theory of relativity this is just what happens. It is possible to deduce from the theory not only such things as the star shift but also certain characteristics of the ultimate nature of things. Such a deduction will be more reliable, the relativitists think, than are our impressions from what our senses tell us. The color-blind man can go through certain scientific tests and can find out thus about the nature of his infirmity. Therefore he knows that things are not really as they seem to him. Just so, say the relativitists, we can find out scientifically that things are not really what they seem to us to be, and we can find out, furthermore, something about what they really are like.

I have said that some deductions about this problem of the nature of things can be made mathematically from the Relativity Theory. The main one of these is the deduction that the real universe has the nature of a four-dimensional something which the relativists call a "continuum," meaning thereby no more than a something which exists everywhere and always; something which is continuous, therefore, both in what we call time and in what we call space.

You will find it easier to do this inferring about the nature of the continuum if you study carefully an illustration devised by Professor Eddington and famous among physicists as the "parable of a penny." I have changed a little the wording of the Professor's exposition.

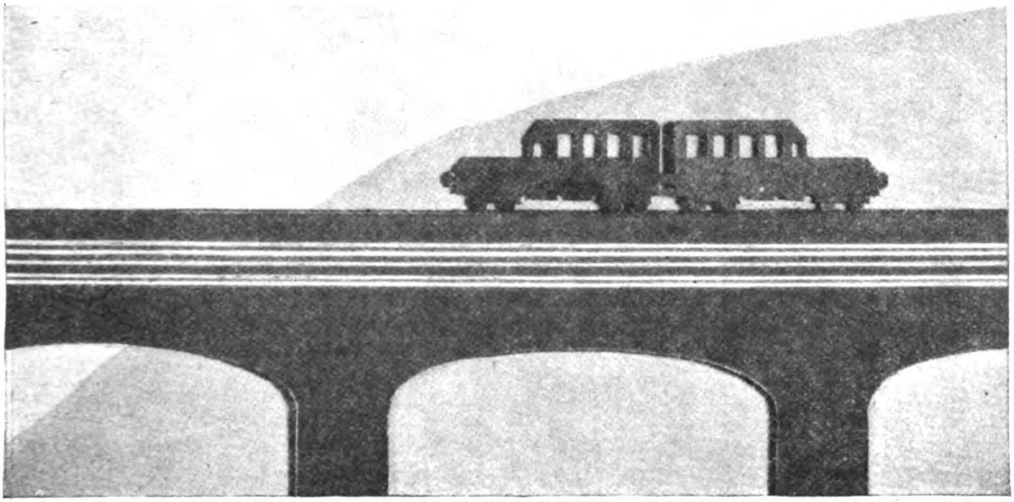
"I hold before me," he says, "a certain object, and see a picture of the head of Lincoln; another observer on the other side sees an ornamental design marked 'one cent'; a third observer to the right sees only a thin copper colored rectangle. Am I to say that the head



Courtesy of Premier Productions, Inc.

WHAT ARE THE INTERVALS BETWEEN FLASHES FROM A LIGHTHOUSE?

It is a fundamental conclusion of the Einstein theory that both time and position are purely relative; consequently this question would be answered differently by a man traveling overhead in an airship than by a man on the earth.



Courtesy of Premier Productions, Inc.

THE FAMOUS "RELATIVITY TRAIN" DEVISED BY DR. EINSTEIN

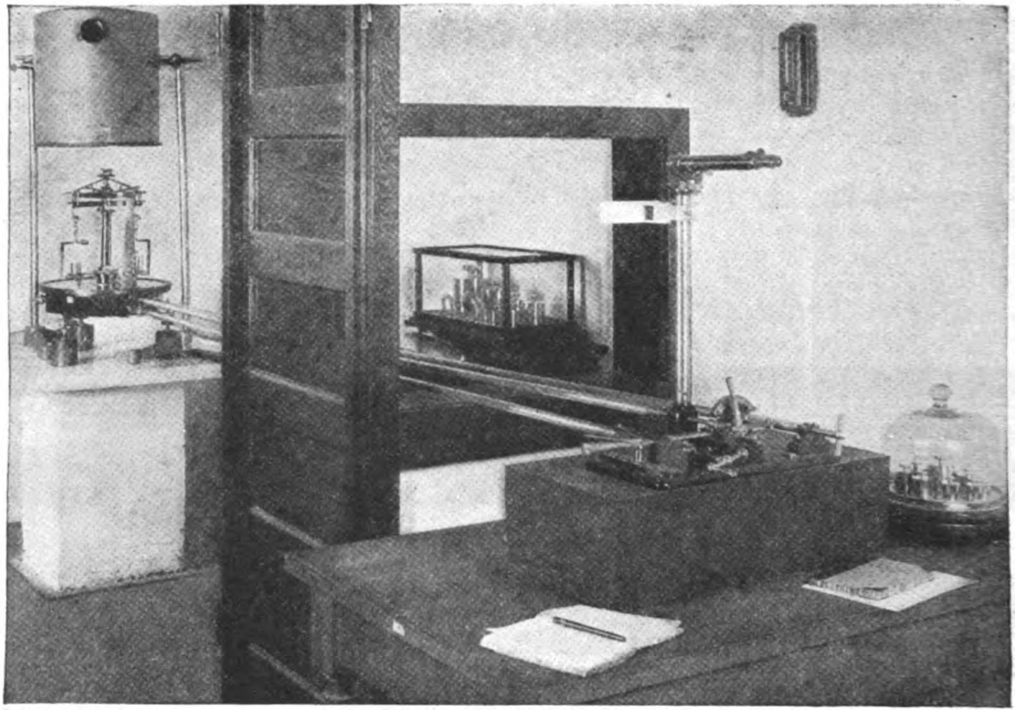
The famous scientist proved that an imaginary train would SEEM *to change in length at various speeds when measured with a beam of light. Even one of our earthly railroad trains would seem shorter if it could move fast enough. At a speed of 100,000 miles a second the train would seem to lose nearly half its length.*

of Lincoln is the real object and that the crude impressions of the other two observers are wrong? Not at all. All three appearances can be accounted for if we are all looking at a three dimension object—a penny—and no reasonable person can doubt that the penny is the corresponding physical reality."

"Similarly," he goes on, "an observer on earth might see and measure something, perhaps a group of stars, and might find it to be an oblong block. An observer on some other star, measuring the same object, might find it to be a cube. Shall we say that one observer is right and the other wrong? Not at all. It is much more reasonable to believe that the thing observed is really a four-dimension something and that both the oblong view of it and the cubical view of it are partial views; are three-dimension aspects of the real thing just as the three separate appearances of the penny were two-dimension aspects of something that had actually three dimensions."

A thorough mental grasp of this illustration will give you an easy key to the whole relativitist view of the universe. Reality is, they say, a four-dimension something which, because of some present limitation of our senses, we are able to perceive only from a series of three-dimension viewpoints. From one of these viewpoints we see things as matter; from another we see things as electricity; from a third we see things as the laws of gravitation. All of these are true, but all are partial, just as were the three separate views of the penny.

Imagine a man with one eye who had never seen a penny or anything like it. Show him the penny; turn it about for him, but do not let him touch it. Having only one eye he will not receive any visual impression of solidity. Everything will look flat. And being forbidden to touch the penny he will not be able to thus correct his impression of its flatness.



Brown Bros.

SOME DAY SOME SUCH MACHINE MAY MEASURE THE WEIGHT OF LIGHT

So delicate is this apparatus in the Bureau of Standards that it must be operated from an adjoining room to avoid the disturbing effects caused by the operator's body. Prof. Eddington of England calculates that the sunlight received each day by the earth weighs about 160 tons.

It will look to him like a changeable flat object, a sort of dissolving view. Only if he is clever or if he has previously seen similar objects which he was allowed to touch, will he be able to infer that the penny is really a solid three-dimension object, his perceptions of which were all one dimension short.

As regards the real nature of things, we are all of us, the relativitists say, in the position of the one-eyed man. Because of some incompleteness of our senses we can observe things only in three dimensions. We see things now from this aspect, now from that one. We never *see* them as they really are. Only slowly are we becoming clever enough to *infer* something about what they really are.

Now what does this mean for the problem which prompted the writing of this article, for the problem of whether or not ether and ether waves are real? Dr. Steinmetz says that there are no ether waves.* Sir Oliver Lodge dissents from this opinion.† What does Einstein say?

On the fifth of May, 1920, Einstein delivered at the University of Leiden a lecture on ether and the theory of relativity. He concluded with the following words, the somewhat free translation being my own:

> Bringing everything together we can say this: According to the General Theory of Relativity space itself is endowed with physical qualities; in this sense, therefore, an ether exists. According to the General Theory, space without ether is unthinkable; for in such a space there could be neither the propagation of light nor the possible exis-

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*In Popular Radio for July, 1922.

†In Popular Radio for November, 1922.

> tence of measuring rods and of clocks. It would be impossible, therefore, to have separation of things in space-time as these words are understood in physics. The ether must not be thought of, however, as endowed with the characteristic property of a ponderable medium, the property of possessing separate parts, the history of which can be followed through time. The property of being in motion or the property of being at rest are alike unthinkable as applied to the ether.

Does this mean that there is an ether or that there is none?

To me it means that the ether exists but that it has properties very different from those ascribed to the old-fashioned space-filling thing which Michelson and Morley tried to detect by their famous experiment.

In Einstein's view the "ether" and the four-dimensional "continuum" come, I think, to mean practically the same thing. This ether-continuum is the substratum of reality. It is the inmost nature of things. By very definition it is not perceivable by our senses or picturable by our mind. We can perceive only its various three-dimension aspects, only the several flat views of the penny. One of these aspects is space, another one is electromagnetic waves, another one is gravitation.

It is not that space is filled with ether; space *is* ether. Space is merely one aspect of the continuum and the continuum is the ether.

We must not say that there are ether waves or that there are not. The truth is that the things we call waves are merely one aspect of the continuum. They *are* ether. They are merely one view of the four-dimension etherial penny.

It is futile to deny that these ideas are difficult to grasp or that they fail of being fully satisfactory to the mind. On this view the ether-continuum appears to be something which must ever remain unknowable to us except by means of dry and lifeless mathematical abstractions. The mind revolts at thus abandoning the problem.

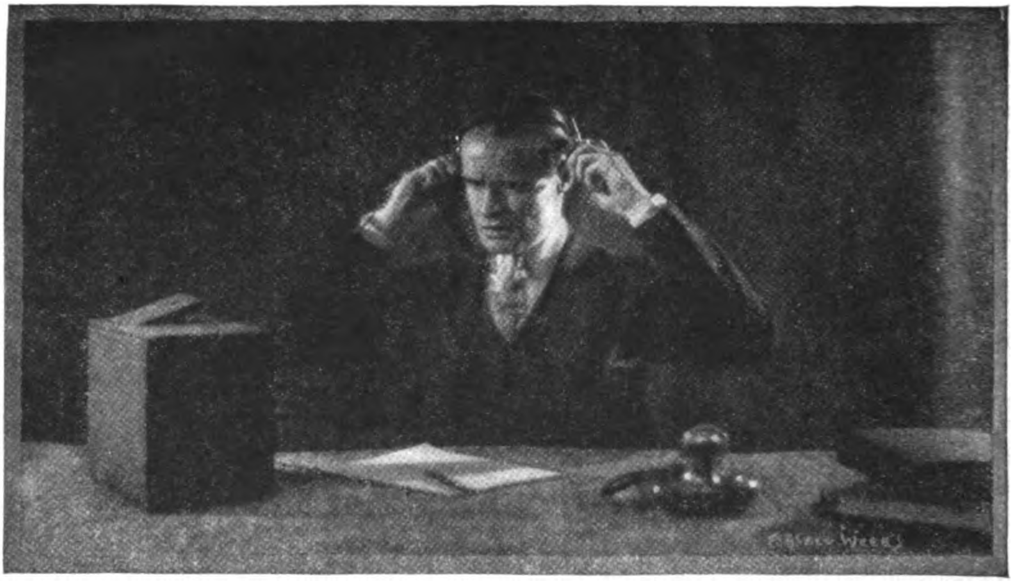
But is it really necessary to abandon it? Is there no hope of being able, some day, to know something directly about the ether-continuum, as though our color-blind man were to recover somehow his power of seeing hues? May we regard the ether problem as fit material for scientific study or must we give it up?

Let Sir Oliver Lodge answer these questions. He wrote in 1921:

> Whether the properties of the ether can ever be formulated in terms of the same sort of dynamics as we have found so fruitful and effective in dealing with matter is at present an open question. Quite possibly a different dynamics may be needed, one perhaps of which we have as yet no conception; but let us not shut the door on discovery, assume that nothing of the sort can ever be arrived at, and think that pure mathematical abstractions, glorified and complicated sufficiently, can be an ultimate embodiment of physical laws or can adequately express the facts of Nature. . . .
>
> We cannot be forever satisfied with a blindfold mathematical method of arriving at results. We can utilize the clues so given, and admire the ingenuity which has provided them. But that is not the end; it is only the beginning. The explanation is still to seek, and when we really know the properties of the ether we shall perceive why it is that things happen as they do.

How to Use Your Radio Set on Your Vacation Trip

In a near issue of Popular Radio *one of the most experienced radio experts in the country will tell, in specific terms, how to set up your receiving set on your motor car, on your pleasure boat and in your camp—and how to avoid the difficulties that will confront the inexperienced fan who is not forewarned and forearmed against them.*



"Interference" *from* Receivers

How to Use Regeneration without Radiation

Many of us know that the howls that sometimes disturb our radio programs are caused by one of our neighbors whose regenerative set is acting like a miniature transmitter when he tunes and passes the wavelength on which we are listening. We hear his radiated energy interfering with our own reception. How to spare your neighbors this nuisance by adding one stage of radio frequency amplification to your set is told in this article by—

JOHN V. L. HOGAN

THE ordinary audion is so much more effective when used with a well-designed feed-back circuit than in a non-regenerative outfit that there are comparatively few grid-tube sets used in the latter fashion.

Regeneration has two points of especial utility:

First, it neutralizes a large part of the wasteful resistance in the ordinary aerial and in the receiver circuits (thus giving louder signals and better selectivity).

Second, it provides a convenient means for receiving continuous wave telegraphy or for picking up telephone carrier waves by employing the self-heterodyne method.

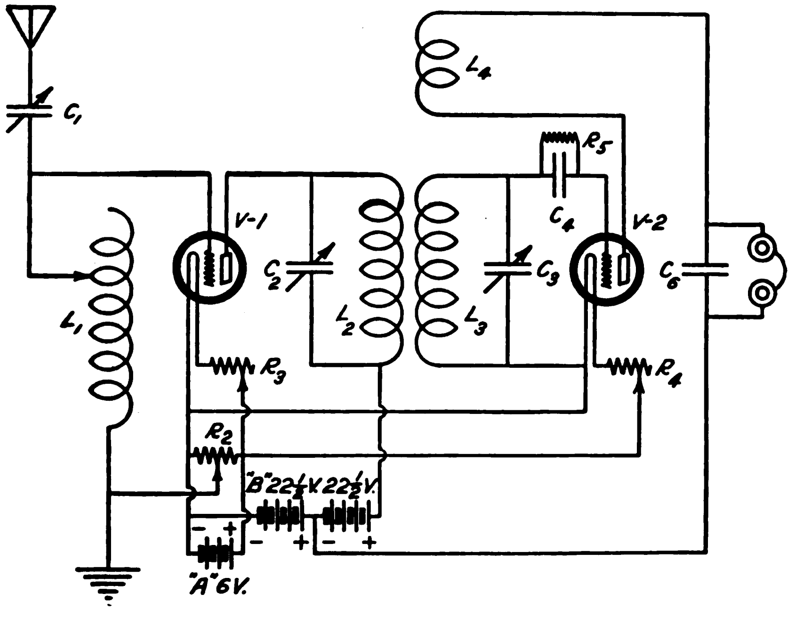
The first of these advantages is perhaps the more useful, especially when it is necessary to use rather poor aerials for receiving.

The second point represents a possibility that is of tremendous help to the individual user of a regenerator, but as it requires the set to be placed in the oscillating state, it may create a good deal of interference to reception by other listeners within a zone of several square miles.

This matter of interference caused by oscillating regenerators seems to be by no means as serious as it was some months ago. When radio novices were setting up feed-back circuits of all conceivable types and, in the absence of competent instruction, were allowing them to oscillate continuously and slightly off-tune from the broadcasting wavelengths, it was nearly impossible to receive a complete radiophone program. Of course these unskilled users themselves heard nothing but whistles, louder than the interfering tones they produced in their neighbors' outfits; largely as a result of this many of them have learned to use their receivers properly without allowing them to oscillate. Self interest has thus brought about a great public benefit.

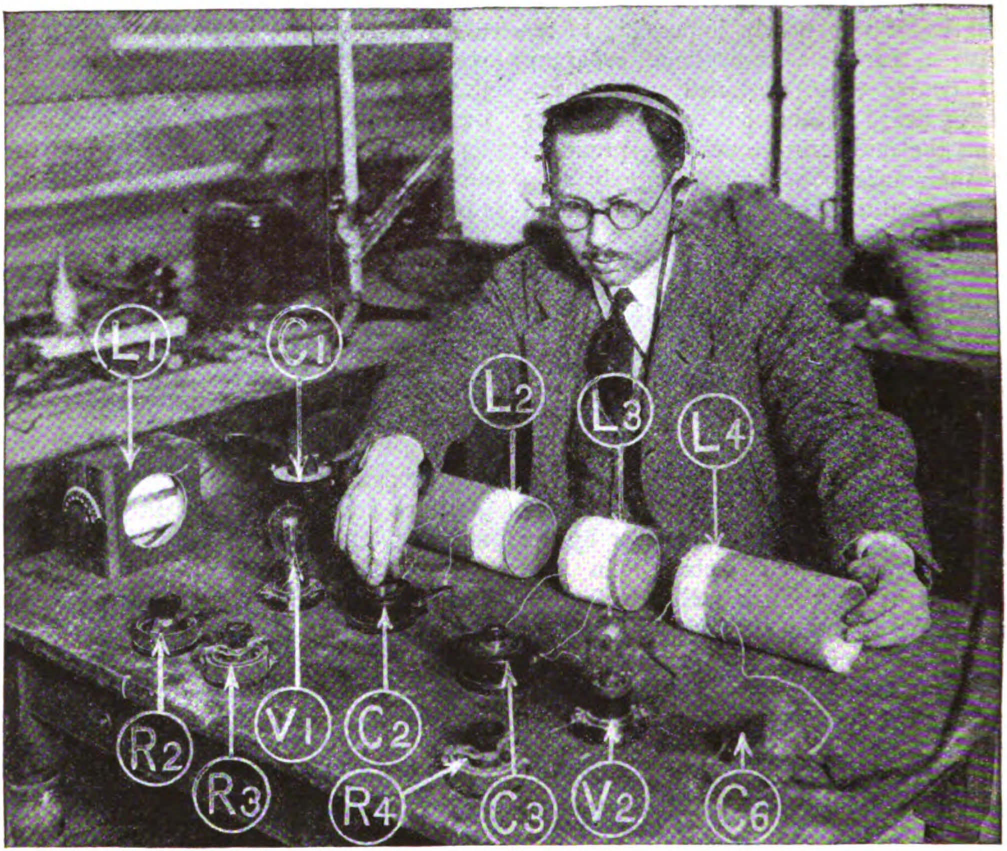
The ideal condition in which there will be no interference from regenerators has not yet been reached, however. Occasionally while listening to a broadcasting station one hears the swinging beat note or whistle which proves that someone in the vicinity is tuning his receiver by the "heterodyne search" plan. In the suburbs of New York such interference nowadays is often only momentary, but there is no need even for that. It is entirely feasible to pick up long distance radiophone signals by tuning one's receiver with the feedback set somewhat *below* the oscillating point, and if this is done it will cause no inconvenience to other listeners. Some otherwise good regenerators are so designed, however, that it is practically impossible to tune over even a rather small band of wavelengths without either readjusting the amount of feed-back or losing the benefits of regeneration. This is especially true of many of the plate-variometer outfits, in which helpful amplification can be had (for a single setting of the plate circuit inductor) only over a small wavelength range. Tuning beyond such limits results either in negligible regenerative amplification or in the production of oscillations that may greatly disturb nearby receivers.

There are several ways in which one may get most of the useful features of regeneration without causing the radiation of interfering waves from his receiving aerial. With these arrangements it is feasible to pick-up signals from distant stations by the heterodyne or beat-note method, and to increase signal intensity by regenerative amplification resulting, in part, from neutralization of circuit resistance. As they



A SIMPLE CIRCUIT THAT INCLUDES A REPEATER TUBE

FIGURE 1—*A circuit with one stage of tuned radio frequency amplification with regenerative detector. This is the "hook-up" of the set pictured on the page following.*



From a photograph made for POPULAR RADIO

THE AUTHOR ILLUSTRATES THE "HETERODYNE-SEARCH" PLAN OF TUNING

Mr. John V. L. Hogan is seen adjusting the wavelength of the plate circuit of the amplifier tube with his right hand, while controlling the regeneration in the detector circuit with his left hand. The "heterodyne-search" plan of tuning may be used with this set, without causing interference to other sets in the neighborhood.

depend, however, upon the use of a radio-frequency repeater between the antenna and the feed-back circuits they will not permit great reduction of aerial resistance; it is consequently desirable to use these circuits with an antenna which is itself of sufficiently good design to be an effective wave-absorbing system.

A simple circuit that includes such a repeater tube is shown in Figure 1. Here the antenna is connected to the ground through a tuning condenser of about 0.0005 microfarad maximum capacitance and an inductor of some 50 or 100 microhenries. Across this coil is connected the input circuit of the repeater tube, as shown; the grid potential can be controlled, from 0 to 6 volts positive of the negative filament lead, by means of the potentiometer. The output circuit of the repeater tube contains the tuned primary of a short-wave inductive coupler; the balance of the circuit is the conventional transformer feed-back or "tickler" arrangement. In making the installation the only point that requires special care is the choice of the proper constants for the coils and condensers that will enable the circuits to tune to the wavelengths it is desired to receive.

The operation of this circuit is a little more difficult than that of the ordinary single-circuit regenerator.

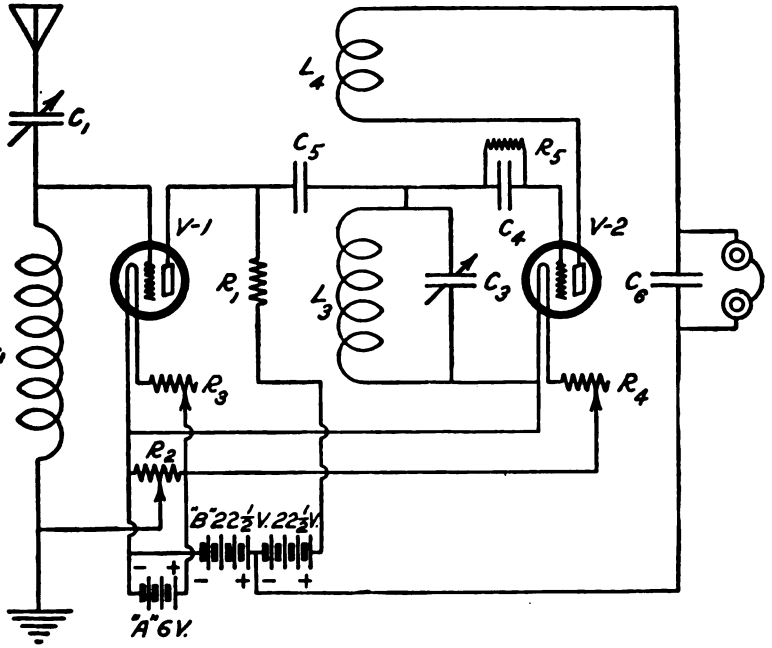
In the first place, there are two sets of circuits that can oscillate independently. The whole idea is to prevent the first tube (repeater) and the aerial from generating oscillations, and to confine this action to the second tube and its circuits.

In the second place, there are three tuned circuits (C_1-L_1; C_2-L_2; and C_3-L_3) and two couplings (L_2-L_3 and L_3-L_4) to adjust. But once the proper constants are chosen and the outfit is correctly set for reception of some particular wavelength, it will not be found difficult to tune to others.

Probably the best way to start using this receiver is to connect it up as shown, then to light only the detector tube, to set coil L_2 as far as possible from L_3 and to couple the aerial coil L_1 to secondary L_3. This makes the set a simple two-circuit regenerator with inductive feedback, and it may be tuned to a nearby broadcasting station in the ordinary way. Thus one can find fairly closely the best values for C_1, L_1, C_3, L_3 and L_4. Of course the final tuning should be done with quite weak coupling between L_1 and L_3, so that the inductance of each coil will not be too greatly influenced by the reaction of the other. There remains only the determination of proper values for L_2 and C_2, and the co-ordination of the adjustments throughout the set.

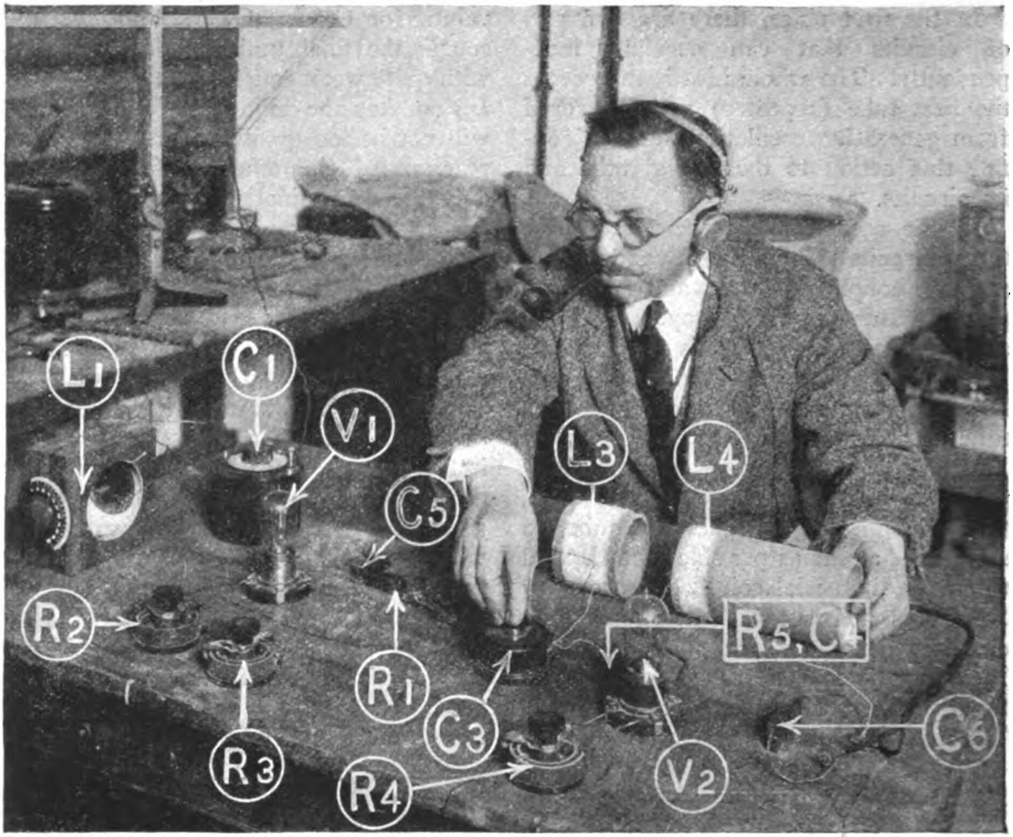
This will not be difficult if the operator now removes coil L_1 from the vicinity of L_3 and couples L_2 and L_3 with moderate tightness—of course, turning on the filament of the repeater tube also. If the potentiometer contact is too near the *negative* end the repeater tube will be likely to oscillate as he adjusts C_2 and L_2, so it is well to turn it well over toward the positive end of the potentiometer winding while he is making his first adjustments.

There is no reason why he should not use identical coils for L_2 and L_3 and the same kind of variable condensers for C_2 and C_3. If he does this, he may



A REPEATER TUBE SET THAT IS EASY TO TUNE

FIGURE 2—*This is a diagram of the set illustrated on the following page. It shows one stage of resistance-coupled radio frequency amplification, with a tuned regenerative detector circuit. This circuit will be found to be easier to tune than the circuit shown in Figure 1.*



From a photograph made for POPULAR RADIO

TUNING THE RESISTANCE-COUPLED SET

The designations of the parts, shown in circles on the photograph, correspond with the designating letters in the text and diagrams. If you want to try out these circuits, you will be able to identify the right parts, and hook them up properly. Mr. Hogan not only explains how to tune these circuits but he gives explicit directions for adjusting each instrument.

set C_2 and L_2 to the same values that have just been determined to the best for C_3 and L_3. Then the whole set can be tuned, simply by making comparatively small changes in the settings of the three condensers.

Once working, the antenna circuit may be left tuned to approximate resonance with the desired wave and the potentiometer set at a point well toward the positive end (so that the aerial cricuit will not oscillate) and then forgotten, until the operator wants to make a substantial change in wavelength. For smaller variations the condensers C_2 and C_3 are handled just like the primary and secondary condensers of an ordinary two-circuit tuner, and the couplings L_2-L_3 and L_3-L_4 are handled like the primary-secondary and secondary-tickler couplings of such an outfit used with regeneration. He can throw these circuits into oscillation by moving L_4 nearer L_3, in order to pick-up carrier waves by means of the beat-tone method, and he can thus get regenerative amplification and selectivity in these circuits. Yet the repeater tube will prevent the oscillations from feeding into the aerial circuit and radiating interfering waves.

The first tube is referred to as a radio frequency repeater rather than an amplifier because little amplification will be had at broadcasting wavelengths if the potentiometer contact is kept far enough toward the positive end to prevent the aerial system and the first tube from regenerating and thus tending to oscillate. By decreasing the positive potential thus applied to the grid the operator can take further advantage of regenerative amplification in this first tube and get considerably louder signals, but if he goes far in this direction he will be back where he started, for the repeater tube will begin oscillating if the coupling L_2-L_3 is slightly reduced and the oscillations will be radiated as interfering waves.

Proper operation of this outfit requires the first tube to remain in the non-oscillating condition regardless of changes in the circuits; the regeneration supplied in the detector tube circuits is used for selectivity, amplification and heterodyne pick-up.

The constants for the instruments used in such receivers have been stated many times, but for the sake of completeness it may be well to repeat. There will be some deviation from normal, in a good many cases, to get best results; but a typical set of values of general utility is the following:

Condensers C_1, C_2 and C_3 of 0.0005 microfarad maximum capacity, preferably fitted with verniers; coils L_1, L_2, L_3 and L_4 each 50 turns of No. 22 B & S double-cotton-covered magnet wire wound on paper or bakelite tubes of 3½ inch diameter, with taps at 20, 30, 40 and 45 turns; potentiometer 200 ohms; filament rheostats 6 ohms; grid leak 2 megohms; grid condenser 0.00025 microfarad; by-pass condenser 0.005 microfarad; tubes UV-201 or VT-1; filament battery 6 volts (storage); plate battery two or three 22½ volt blocks. A good antenna would be a single wire from 100 to 150 feet long (including down-lead) with the horizontal portion some 40 feet or more above the earth. All of these values are stated for use on amateur and broadcasting wavelengths.

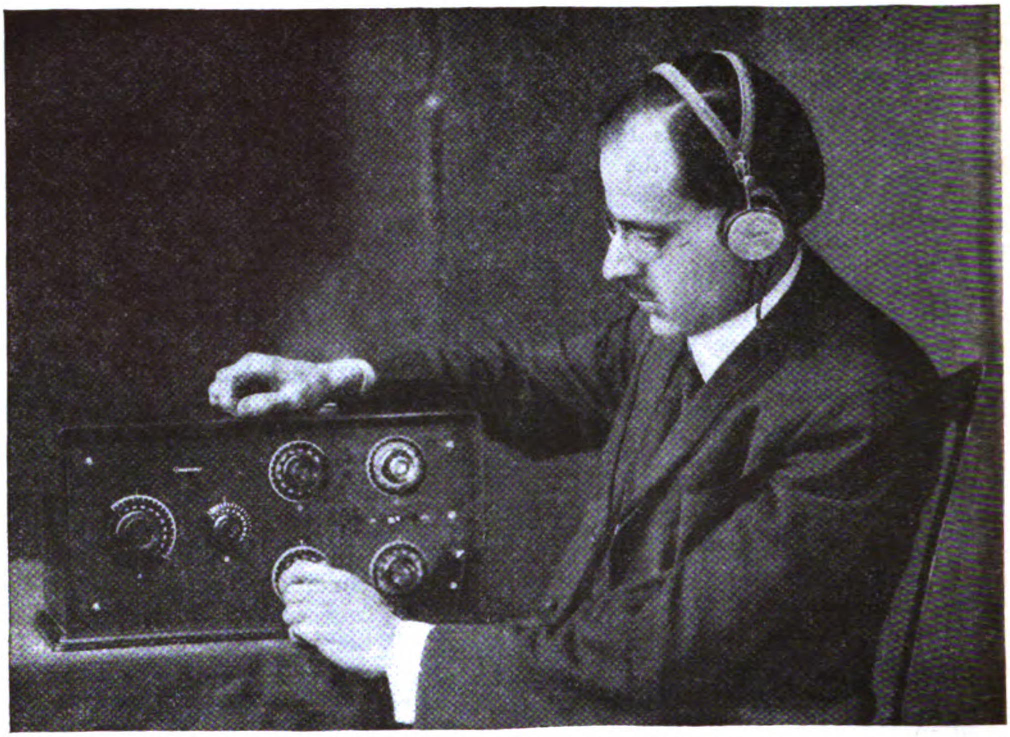
A little additional ease of adjustment may be had, at the cost of some selectivity, by using the circuit of Figure 2. The elements are the same as before, except that C_2 and L_2 are omitted and R_1 and C_5 added. R_1 is a coupling resistor of about 50,000 ohms and C_5 a fixed condenser having about 0.0005 microfarad capacitance. With this arrangement the only important variables, once the set is adjusted to approximately the best condition, are C_1, C_3 and the coupling between L_3 and L_4.

It will be found that with the Figure 2 circuit there is much less tendency for the repeater tube to produce oscillations in the aerial circuit; and that the potentiometer contact can be moved much nearer its negative terminal. Further, the tuning is considerably simpler than that of Figure 1. It will be noted that the plate circuit potential of the repeater should be increased to about 60 volts in order to offset in part the effect of the resistance unit R.

Either of these two circuits is capable of sharper tuning than the ordinary single-circuit regenerator and, on a good aerial, will give excellent results. With reasonable care in adjustment the user can do all the searching for long-distance stations he may desire, taking the full advantage of the beat-note for locating weak signals, and yet be secure in the knowledge that he is not interfering with his neighbors.

2,400 MILES ON A $40.00 SET!

The next number of POPULAR RADIO *will announce—and describe in specific detail—the most efficient receiving set that can be made for a low price; the remarkable new "Four-Circuit Tuner," the new invention of Laurence M. Cockaday. It can be made at a cost ranging from $30.00 to $40.00; it has a verified* C. W. *range of 3,200 miles and a telephone range of 2,400 miles, and it makes possible a sharper tuning than any set that has so far been developed. Order your May number from your newsdealer* TODAY!



AN AMATEUR WHO BECAME AN EXPERT

Fifteen years ago Mr. Donle was a typical radio fan in Providence, Rhode Island. His interest in experimental work in both ionization and in pure electron vacuum tubes led to numerous inventions; he is now chief engineer of the Connecticut Telephone and Electric Company, in charge of its radio research activities; the "Donle tube" is his latest contribution to science.

The Most Sensitive Tube

IN THE WORLD

A remarkable device that operates with a plate of liquid sodium instead of solid nickel and that picks up signals on a stream of ions instead of electrons; described by its inventor—

HAROLD P. DONLE

A NUMBER of years ago we completed a survey of the field of radio receiving. The purpose of this study was to determine the relative opportunities for improvement in the several subdivisions of receiving apparatus. The conclusion reached was that a great margin for advance existed in the process of detection. The phenomena of rectification were not completely understood apparently, and the efficiency of conversion shown by even the best detectors seemed to be quite small.

Since that time a substantial portion of our research and development work has been directed toward improving detector operation.

Having found a number of inherent limitations in the grid type detector tube, and realizing the dangers of interference-production by oscillating regenerators, we set as our goal the development of a new detecting structure that would have so great efficiency that regeneration would be unnecessary. This was a large problem, and its solution has required a great deal of time and effort; even a summary of all the work done would make a long story.

In the course of this development we have produced several distinct types of detectors. Many of these had decidedly interesting (and, indeed, valuable) characteristics but in some cases the device possessed some weak feature that tended to neutralize its good qualities. As may be imagined, the research work has been extensive. Thousands of operative tubes have been built and studied; to analyze the performance of each has required a complete set of operational characteristics for every tube; even the labor of taking tens of thousands of observations for these curves was no light task. Our latest development, the intensifier tube, which was recently described before the Institute of Radio Engineers, incorporates many of the features worked out during the research just outlined.

In this very tube we have a non-amplifying vacuum tube detector of remarkable sensitiveness and stability. When using this tube in a properly designed two-circuit receiver, we invariably reproduce radio signals more strongly and more clearly than we can produce with a standard regenerator with a grid-tube. The high sensitiveness secured is largely due to the arrangement of electrodes used, in conjunction with ionization of an alkali metal such as sodium.

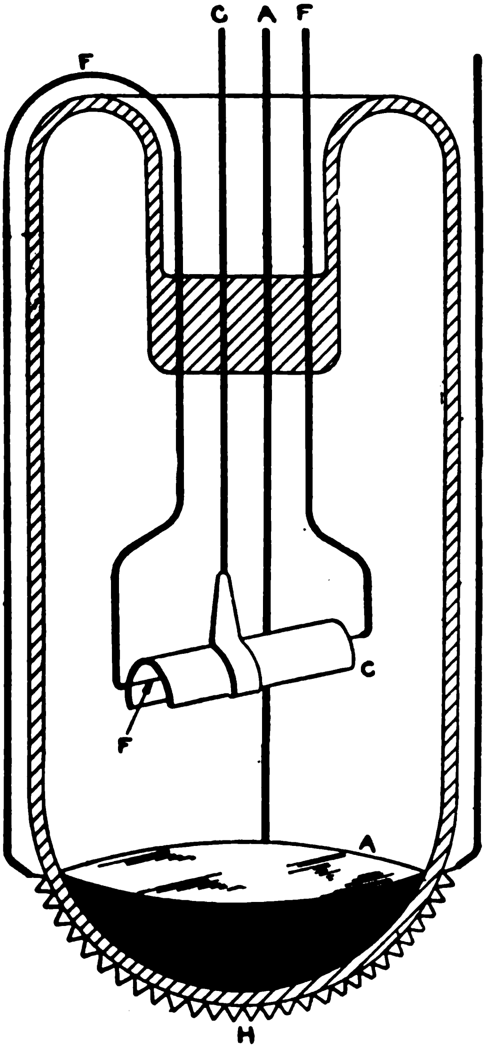
The new electrode arrangement that is utilized is not in itself sufficient to account for all the results; the structure works inefficiently in the absence of ionization, for ions are responsible for the accumulated charge on the "collector" electrode. Responses to signals are obtained in this tube by a breaking up of this charge when radio frequency impulses are impressed on the detector; the result is a relatively great change in the steady value of the current in the collector-filament circuit.

When a regenerator is adjusted for maximum sensitiveness, just short of self-oscillation, the circuits have a low effective resistance which results in a "tailing out" of speech or music and prevents clean-cut reproduction. This effect cannot be had with the intensifier, for its circuit and mode of operation are non-regenerative. Similarly, the intensifier cannot produce interference with reception by others; it is not capable of adjustment so as to radiate energy at the working wavelengths. This helpful characteristic, which allows the user to tune at will without fear of disturbing other people, caused Dr. Chaffee to christen the device "The Golden-Rule Tube."

Figure 1 shows a conventionalized cross-section of this new tube. A glass bulb contains the straight filament F, the collector electrode C (which is a trough-shaped piece of sheet metal supported above the filament) and the main anode A at the bottom of the tube. This anode is, in this particular form of tube, a button of metallic sodium. Connections to the electrodes are provided by way of the three wires that are shown; the second filament lead is brought out through an external heating coil H mounted outside of the tube proper.

The filament current passing through this heater serves to maintain the sodium anode at the correct operating temperature. The four terminals are brought out to the prongs of a standard detector base.

A useful circuit for taking advantage of the intensifier's characteristics is shown in Figure 2. The left-hand portion of the diagram is simply a form of the well-known two-circuit tuner. The detector connection is somewhat unusual, however. Current for heating the filament and the anode is drawn from a 6-volt storage battery, in the tubes now available, and is controlled by a rheostat R. The average current value is about 1.6 amperes. The anode circuit contains the telephones and a dry battery of any convenient potential between 10 and 30 volts; no adjustment of the anode potential is necessary, for the battery may vary widely without much effect on signal strength. No by-pass condenser is needed across the telephones (or transformer primary, if an amplifier is used) for no radio frequency currents appear in the anode circuit. The anode current is about 150 to 200 microamperes.



THE PARTS OF THE TUBE

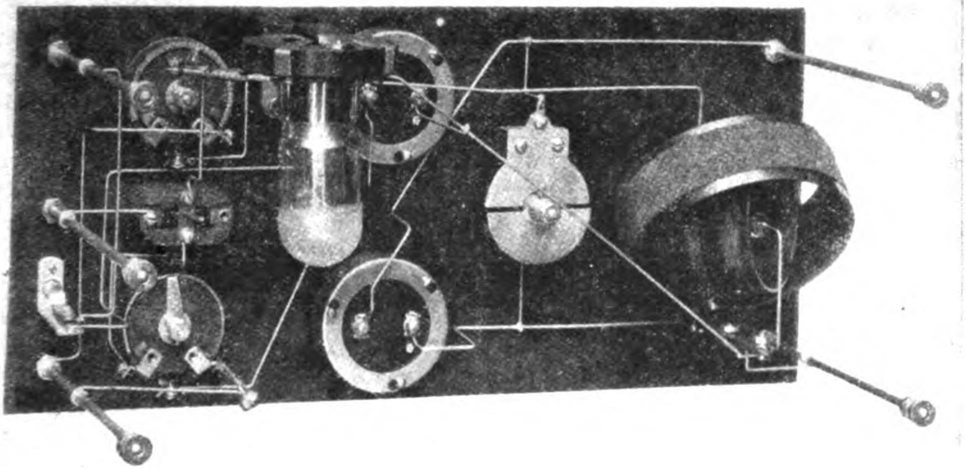
FIGURE 1; *F is the filament, connected in series with the heater element H, which heats the anode A, causing it to give off ions that fly over to the collector plate C. All of these elements except the heater are enclosed in the inner glass shell.*

The most interesting thing is, however, the connection and behavior of the collector circuit. No stopping condenser or leak resistance is used, and the tube will not work properly if there is any such obstruction to prevent flow of current in the circuit from filament to collector.

The steady value of current in this collector circuit is relatively high; if the collector is connected directly to the filament it will measure as much as 1,500 microamperes or some ten times the normal anode current. To control the collector current conveniently a variable opposing or neutralizing potential is introduced by means of a potentiometer across the filament battery. The larger this neutralizing e.m.f. the smaller the collector current; the normal adjustment is in the neighborhood of 1.4 volts, giving a current of 600 to 800 microamperes or about four times the current in the anode-telephone circuit.

Another interesting feature is that this large collector-circuit current does not flow unless the anode circuit is closed. If we break the telephone connection, the anode current is of course interrupted. But the collector current at once falls to something like half its normal value. This unusual feature is one of the characteristics that identify the new phenomena used in this intensifier tube.

If microammeters are placed in both the collector and anode circuits, the steady value of current in each will be seen to drop as soon as radio signals are applied. The change of current on receiving signals is much greater than with grid tubes, and gives us not only a convenient way of measuring directly on a meter the intensity of quite weak radio waves but also an easy method of operating a telegraph relay on a telephone call-bell by radio. For instance, ordinary daylight signals received at Meriden (on a small aerial) from WOR at Newark, a hun-



AN INSIDE VIEW OF THE NEW RECEIVER

Notice that the tube is mounted in an inverted position. The arrangement of the various instruments and the wiring is clearly shown. All the connections to the set are made from the rear.

dred miles away, cause a drop in collector current of about 50 microamperes; it is simple to arrange a relay to be operated by such a current change.

The large effect which signals produce on the collector current makes it feasible to place the telephones directly in the input circuit. In this case, the anode circuit includes nothing but its battery and the collector becomes both input and output electrode. The collector circuit is one of low impedance, however, and the usual telephones are not suited to it. Their resistance also interferes to some extent with tube operation, so that it is better as a practical matter to place the telephones in the anode circuit. Nevertheless, for a given resistance in the collector circuit signal responses are as loud with the telephones in the input as in the anode circuit.

One other operating feature should be mentioned—selectivity.

Although with the intensifier we have no way of reducing circuit resistance by regeneration, the extraordinary sensitiveness of the device permits us to use exceedingly loose coupling in the receiving tuner. As is well known, this produces not only a high degree of selectivity but also gives great freedom from impulsive interference produced by static or nearby spark stations. Further, the intensifier has a valuable frequency-selecting power of its own; adjustment of filament current and collector potential permits discrimination between neighboring wavelengths by increasing the sensitiveness of the tube to any particular desired wave frequency within its range. As built for broadcasting reception the tubes may be adjusted to give maximum response to 360 or to 400 meters and at the same time to be poor detectors of interfering signals on 600-meter or longer wavelengths. The net result of these several possibilities is to give a practical and easily secured selectivity that is much higher than is ordinarily required.

Experimenters whose only experience with detectors utilizing ionization phenomena has been confined to grid tubes containing gas are likely to believe that any ionization effect must be of unstable or transient character. A little work with one of the intensifiers will quickly demonstrate that it is the gas and not the ionization that causes the fugitive, rapidly changing adjustments of the old tubes. By using ionization of a metal vapor, and particularly of an alkali metal, we are able to produce in quantity detector tubes which have definite characteristics and the operation of which is uniform throughout the period of use. Control of the ionizing anode temperature gives us complete control of tube operation, and in order to keep an intensifying detector adjusted to maximum sensitiveness for hours at a time it is merely necessary to set the filament rheostat at a value that will maintain the requisite heating and to adjust the collector potentiometer at the best point for the particular signal strength and frequency, and leave them there.

As may well be imagined, we have had our own troubles in producing a tube of this kind. The operation is so radically new that we not only had to develop the device itself but also new methods and apparatus for testing it. The usual schemes used for investigation of grid tubes are of little value to us; for example, the absence of amplification and the presence of a relatively large direct current in the input circuit are not taken care of in the ordinary methods of measurement.

The experimental work has been well worth while, however, for we now have a dependable detector of higher sensitiveness than has ever been reached, yet one which cannot produce interference. Continuation of the investigation is showing further possibilities of increased sensitiveness, and present-day indications are that filament current consumption can be reduced to a point that will permit of dry-cell operation without loss in stability, selectivity or responsiveness of the new tube to radio signals.

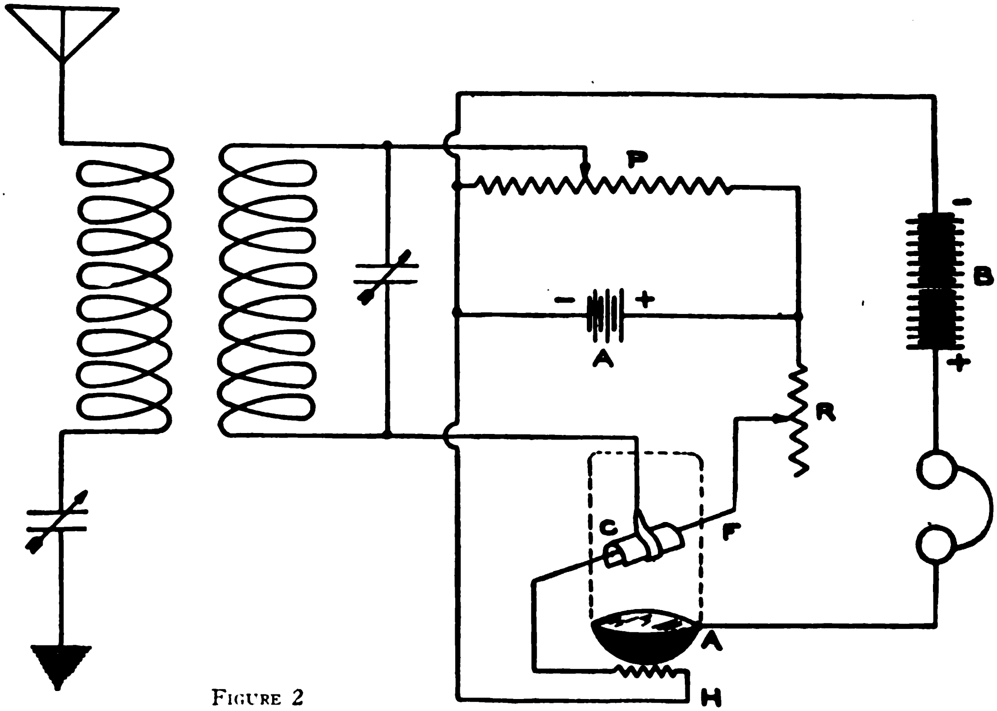
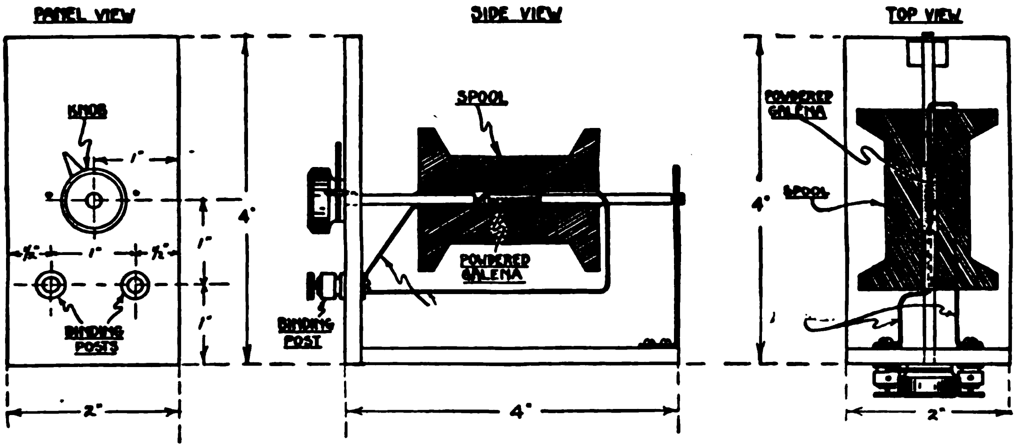


FIGURE 2

The electrical connections for the set that makes use of the intensifying properties of the new tube. This circuit has proven of exceptional sensitivity in detecting radio signals.



If you own a crystal detector set, you know how troublesome it sometimes is to find the "sensitive spot" on the crystal. Here is a home-made set that locates this spot for you. When the knob is rotated the powdered galena naturally tumbles into the right position between the catwhiskers.

How *to* Make a Crystal Detector *from* a Spool

By ALBERT GRUBER

MANY amateurs discover that it is difficult to find the sensitive spot on the crystal used as detector in their radio sets. The spool type of detector will eliminate this difficulty if constructed properly. The size of this detector is entirely optional to the maker and various dimensions may be used with success.

First obtain two panels the same size; 4 by 2 inches will suffice. Also four inches of a dowel pin the size of the inner diameter of the spool you are going to use.

Drill a hole the size of the diameter of the dowel pin used, in the exact center of the one panel. Two smaller holes are drilled for binding posts one inch from the bottom and each one-half inch from the side.

Place two small-gauge wires for catwhiskers in the hole of the spool in such a manner that the wires are on opposite sides and do not touch. Saw off 1¼ inches of the dowel pin, spread paste on one end and place in one end of the spool a distance of ½ inch.

Now fill the spool with powdered galena crystal, leaving enough space for the placing of the dowel in the other end of the spool. Be careful to keep the wires in place and be certain that the grains of galena will move freely when the spool is rotated. The balance of the dowel is pasted in place.

The panel should next be screwed to the base and a rear support made of a brass strip. The holes for the support of the rod should be in line with each other.

Place the spool detector in position securing it with small nails, one driven through the dowel at the rear of front panel, the other at the rear of the support.

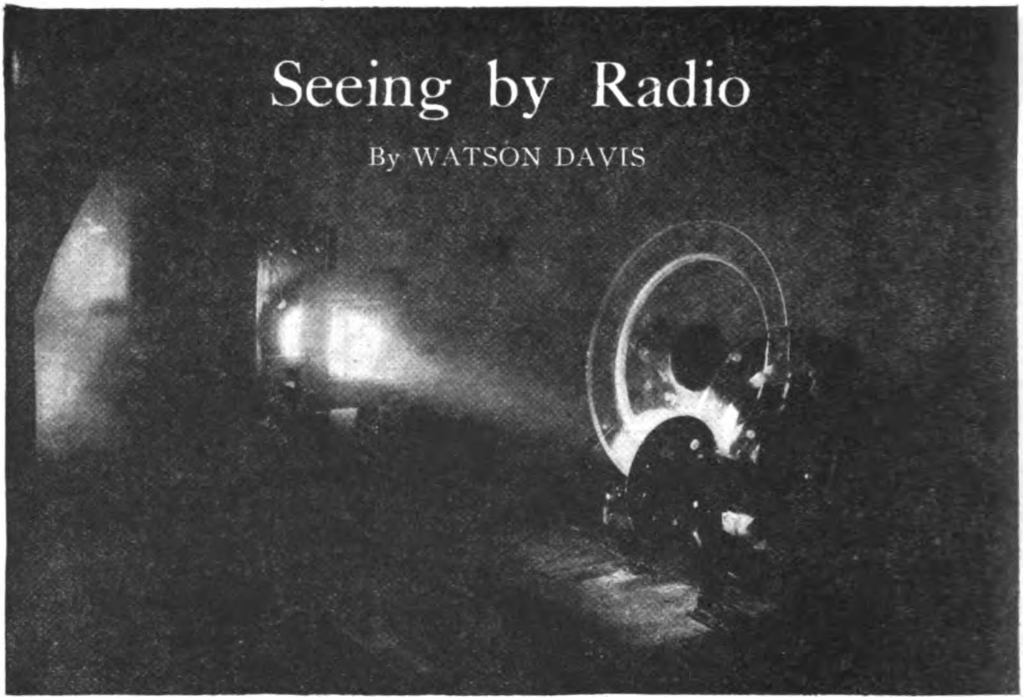
A dial or knob may be pasted on the part of the dowel that extends through the front panel, for adjustment of the detector.

The two catwhiskers are connected to the two binding posts. To operate, rotate the handle slowly and the wires inside the spool will come in contact with at least one sensitive spot in the galena.

This general plan may be varied in many ways without decreasing the efficiency of the detector.

Seeing by Radio

By WATSON DAVIS



From a photograph made for POPULAR RADIO

A Revelation of Some of the Wonders That Radio Holds in Store

PHOTOGRAPHS are now being sent by radio. As soon as the process is speeded up, motion pictures may be similarly sent. We may shortly see on the screen distant news events almost as soon as they take place; we may see at eleven o'clock in San Francisco an accident that "will occur" in New York at two o'clock the following afternoon! How these astonishing developments are made possible is something more than hinted at in this article—which contains the first detailed description of the remarkable invention of C. Francis Jenkins.—EDITOR.

BEFORE there were motion-picture theaters, C. Francis Jenkins was a real-life actor in some wild-west dramas in southwestern United States and Mexico. Before he came to Washington he got the fool idea of trying to solve the problems of motion pictures. Many other inventors of that time were also giving their best thought to apparatus that would bottle up motion and reproduce it at a later date. But Jenkins finally perfected movies, and today his contribution to the motion picture machine is in use in every commercial projection machine on the market—except his own.

And that is the beginning of the story of the possibility of seeing by radio.

If you have watched a motion-picture projector in action you will remember the slotted disk in front of the lens that, twirling around, blots out the image of the film when it is in motion. The film in the standard motion-picture machine moves with jerks and you see the image on the screen only when the film is stationary; the whirling shutter wheel suppresses the rest, but does it so fast that your eye cannot catch it doing it. Mr. Jenkins is responsible for the long opening and resultant long exposure in this shutter wheel that gives the illusion of continuous motion on the screen and makes motion pictures possible. And he also introduced the device that produces the jerking motion of the film.

To be the father of one of the essentials of the motion-picture machine would seem enough achievement for an inventor. But if Mr. Jenkins invites you to a movie show in his laboratory on Connecticut Avenue, Washington, D. C., you will find a new kind of machine. The shutter wheel is conspicuous by its absence. There is no shutter; the light plays on the screen for the full time and not just part of the time. The film is in constant, continuous motion; it does not jerk along. A glass disk or wheel revolves perpendicularly to the beam of light which is projected through it near its edge and which carries the picture image.

If you examine the disk of common glass you will find that it has an edge of varying thickness. It is, in fact, a prism cut on the circumference of the disk. But it is not just an ordinary prism, for it has a constantly changing shape. At one end its base is at the edge and at the other its base is inside. Where the two ends meet there is an abrupt change, and directly opposite on the other side of the circumference the prism at that one point is just a piece of glass with sides parallel.

This "prismatic ring," as Mr. Jenkins calls it, is the essential part of the device for sending and receiving pictures by radio and it is the only new part.

Have you ever been in the old-fashioned houses that still have prismatic ornaments suspended from their chandeliers? Or do you remember a little of the physics of light that you learned in your high-school days? If so, you will know that the direction of a ray of light is changed by passing through a prism; that is, the ray is bent toward its base. It is this property of the prism that is used in applying the prismatic ring. A beam of light projected through the revolving prismatic ring will be refracted from one side to the other with the ring as the hinge.

In the Jenkins continuous motion-picture machine the light passing through the picture on the film is picked up by the prism and carried across the screen at the same rate that the film is traveling. If sixteen pictures each second are projected in this way, the action on the screen seems to be continuous.

This principle and these rings are used in the apparatus designed for sending pictures from place to place by wire or radio. The essential difference in the operation of the continuous motion-picture machine and the apparatus for sending pictures is that the picture transmitting apparatus projects the picture a small portion at a time, while the motion-picture machine throws the whole picture on the screen at the same time.

In order to send only a portion of the picture at one time, Mr. Jenkins uses two prismatic rings. These are so placed that their diameters intersect at right angles and the beam of light passes through both prismatic rings at the intersection. The ring that shifts the beam from left to right runs about a hundred times as fast as the other ring whose prism causes the image to move from the top to the bottom of the picture. The total effect of the two rings working together in the receiving set is that of a pencil of light tracing lines across the picture about a hundred times as fast as it moves downward.

In both transmitting and receiving apparatus there are duplicate sets of these rings and they do exactly the same thing. The transmitting set picks up the light from the picture to be sent, shoots it through a lens and impresses it upon a light sensitive cell. In the transmitting set there are only three essential parts; the set of prismatic rings, a lens to converge the light, and a light sensitive cell.

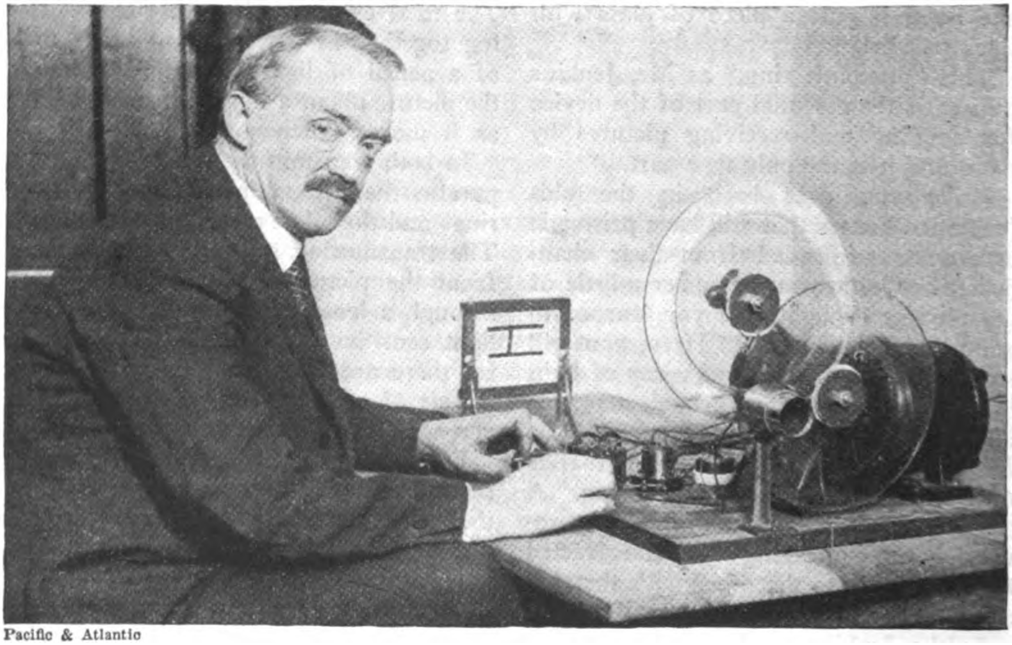
Do you remember the invisible eyes that guided our troop ship convoys across the Atlantic during the war?

This was accomplished by light sensitive substances, and it is this class of substance that is used in Mr. Jenkins' transmitting set. When a selenium or thalium salt is in the light it allows a greater amount of current to pass through it than when it is in the dark. The light sensitive cell that Mr. Jenkins is now using is composed of thalium sulphide. When the prismatic rings impinge the picture point by point upon the light sensitive cell, the different light values of the different points cause variations in the electric current passing through the cell. This current of varying intensity is fed into a land telephone or radio transmitter and sent by wire or radio to the receiving apparatus, just as though it were a modulated current produced by talking into a telephone transmitter. It may be transformed into radio frequency, it may be amplified; the only essential thing is that it reach the receiving apparatus with the same variations of intensity.

The Jenkins transmitting apparatus has been in operation at NOF, the Navy Department's radio station at the Naval Air Station, Anacostia, D. C. Various photographs and line drawings have been sent to Mr. Jenkins' laboratory on Connecticut Avenue about five miles away. An ordinary nitrogen-filled lamp was the source of light and the photographic negative was placed between the lamp and revolving prismatic disks. To and fro the picture was thrown by the disks until in six minutes every point in the picture had been projected onto the light sensitive cell across the room enclosed in a protective cage or screen. Between the prismatic disks and light cell there was a "chopper," which consisted of a rapidly revolving perforated disk interrupting the current in such a way that it produced a variation. This caused an audible telephone signal in radio receiving sets that were tuned in on the proper wavelength, 425 meters, that was being used.

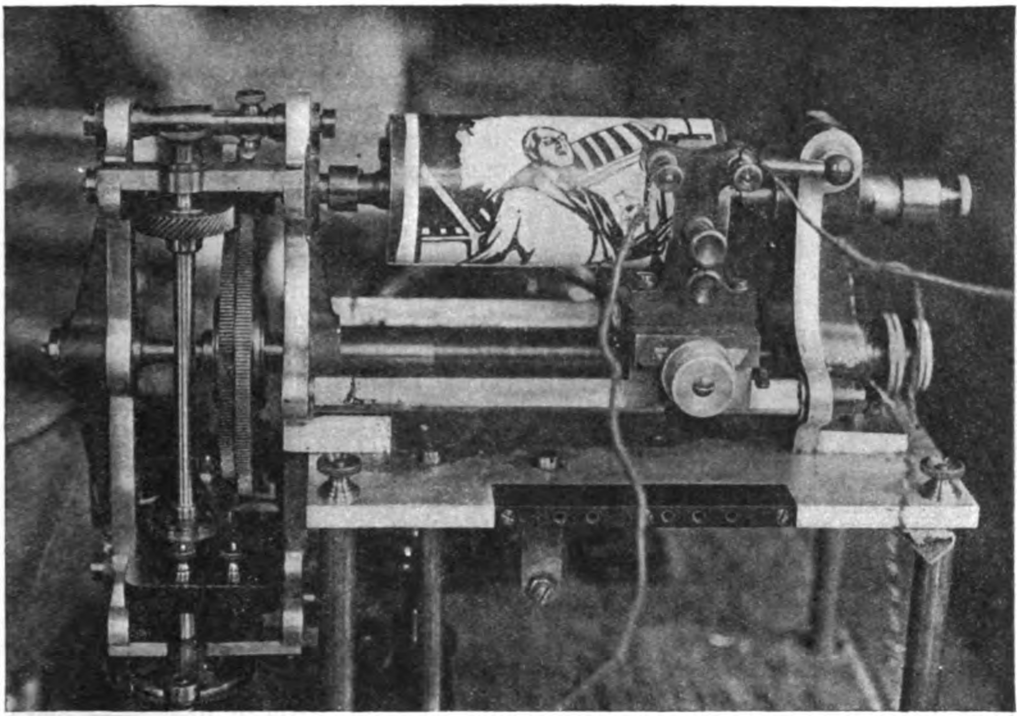
Radio fans have been able to *hear* the picture being sent.

In the radio picture receiver, the incoming current moves a small mirror. The extent of this movement depends upon whether the current represents a light or dark place in the picture that


Pacific & Atlantic

THE WHIRLING GLASS RINGS THAT PERFORM THE WONDER

These two glass discs (one of which revolves 100 times as fast as the other) literally "pick a picture to pieces." The "pieces" consist of horizontal lines of light and shadow that are traced from the film and are flicked across the screen at the rate of 16 complete pictures a second. The inventor, C. Francis Jenkins, is shown operating the device.



International

THE BELIN APPARATUS RECEIVES A PICTURE BY RADIO

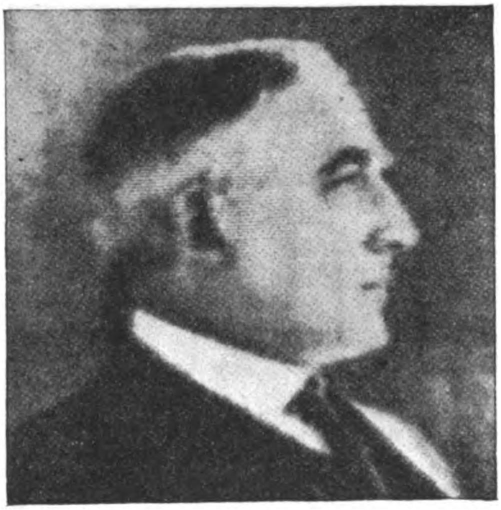
The sliding arm, seen in the photograph with the two wires attached, slips across the rotating drum and records the picture that is being transmitted. It is the invention of a Frenchman, Edouard Belin.

is being transmitted. A beam of light, broken by the shadow of a human hair, is reflected by this mirror so as to pass through a slit and be impressed upon the photographic plate by the prismatic disks. When black is being sent, the reflected shadow of the hair completely excludes the light from the plate, but when a light portion of the photograph is being received the mirror vibrates and lets through sufficient light to reproduce the tone of the original photograph.

At present the motors which revolve the prismatic disks are synchronized through the use of the same city source of A. C. current, but Mr. Jenkins will use motors synchronized by tuning forks in the tests between cities. The synchronization of the revolutions of the disks is, of course, necessary to prevent distortion of the picture.

An ordinary spark or arc radio telegraph transmitter will transmit black and white or line drawings by the Jenkins method. The distance that such a picture can be transmitted is limited only by the range of the set. For the sending of photographs with their minute variations of tone, a high-grade telephone broadcasting transmitter, such as that installed at NOF, is needed, just as such a station is necessary to transmit the human voice. In this case also the range of picture transmission is only limited by the range of radio telephone transmission. Where the voice can be broadcast, the photograph can go also. Similarly photographs can be transmitted by the Jenkins method over ordinary telephone wires at ordinary frequencies or at carrier frequencies such as are now used on long-distance toll lines.

In one respect the transmission of photographs is simpler than that of the sound; there is no frequency variation in photograph transmission, as the varia-



PRESIDENT HARDING—BY RADIO

This is a specimen of a photograph as received by the Jenkins invention. Note the faint, horizontal lines.

tions in the shading of the picture are translated into current intensity variations only.

The results of the transmission are splendid pictures—photographs that rival the work of the most expert artistic photographers. They appear to have the quality of a steel engraving. The faint horizontal markings remind one of a photograph printed on very finely marked linen paper. The contrast and sharpness of the pictures are sufficiently good so that clear half-tones can be made from them suitable for newspaper and magazine use.

Motion pictures and "seeing by radio" are described by Mr. Jenkins as the next step in his process. To make still pictures move, more speed and light are necessary. Mr. Jenkins feels sure that these requisites can be achieved. He mentions his high-speed camera that can take 48,000 pictures a minute, and he tells how the simulation of motion will be obtained.

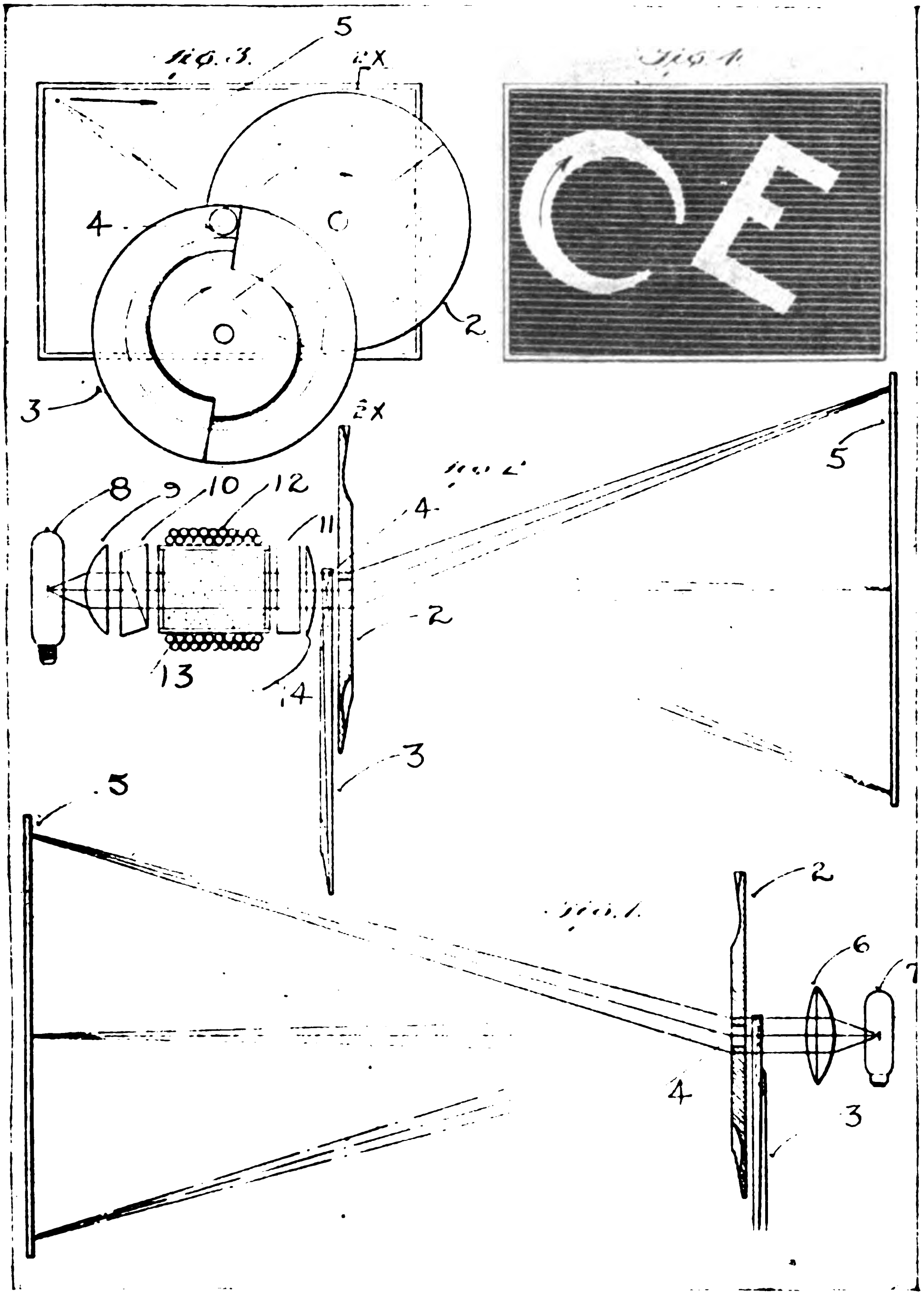
In order to make the projection appear continuously in motion, sixteen whole pictures must be flashed on the screen each second, just as is the case in the ordinary motion-picture machine today. That means that the up and down movement of one of the prismatic rings must be accomplished in one-sixteenth of a second and as the left to right motion is a hundred times as fast, the other ring must revolve 1,600 times a second. The light sensitive cell is ready for a new intensity of light 200,000 times a second. This would divide the path of the horizontal motion into over a hundred different light modulations which would, in Mr. Jenkins' opinion, give the necessary detail. The result would be a series of lines of light of varying blackness drawn so fast and so close together that they would form a complete picture, like the dots in a half-tone print. Because of the short time that each portion of the screen will be illuminated, an intense light source will be necessary.

Other inventors have been hard at work on the problem of sending drawings and photographs by wire. One of the most successful of these is Edouard Belin of Paris, whose progress is told in the French technical press.

The Belin process, like that of Jenkins, consists in converting the variations in the details of a photograph, or other matter to be sent, into corresponding variations of electrical current which are transmitted over the wires or by radio just as any other telegraphic message would be. At the receiving end these current variations are translated into terms of light so that a copy of the original picture is obtained. But the method of conversion is different.

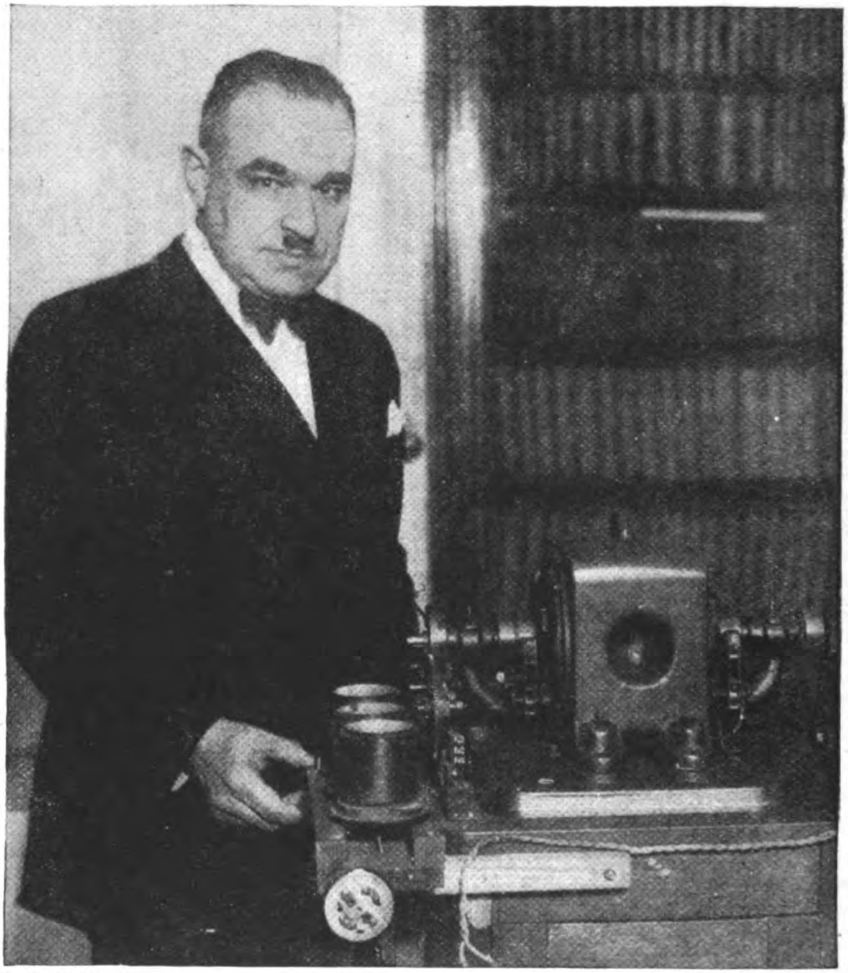
It is perhaps easier to see how this is done in the case of simple-line drawings, finger-prints and other solid black and white matter. The sketch of this kind which is to be sent over the wires or by radio, is made upon paper with an ink which leaves a slight deposit when dry and so makes a drawing in low relief.

This paper is placed upon the cylinder of a machine which resembles the ordinary cylinder phonograph and which is propelled by clockwork in much the same way. Resting on the cylinder there



HOW THE JENKINS DEVICE DRAWS PICTURES WITH PENCILS OF REFRACTED LIGHT

Figures 1 and 2 show how one disc throws a pencil of light slowly down the film while the other disc throws one in swiftly drawn horizontal lines. Figure 4 illustrates how these lines are combined to form the picture. Figure 3 shows the two discs in operation. The upper disc causes the horizontal motion of the beam of light and the lower disc causes the vertical motion across the picture to be sent.



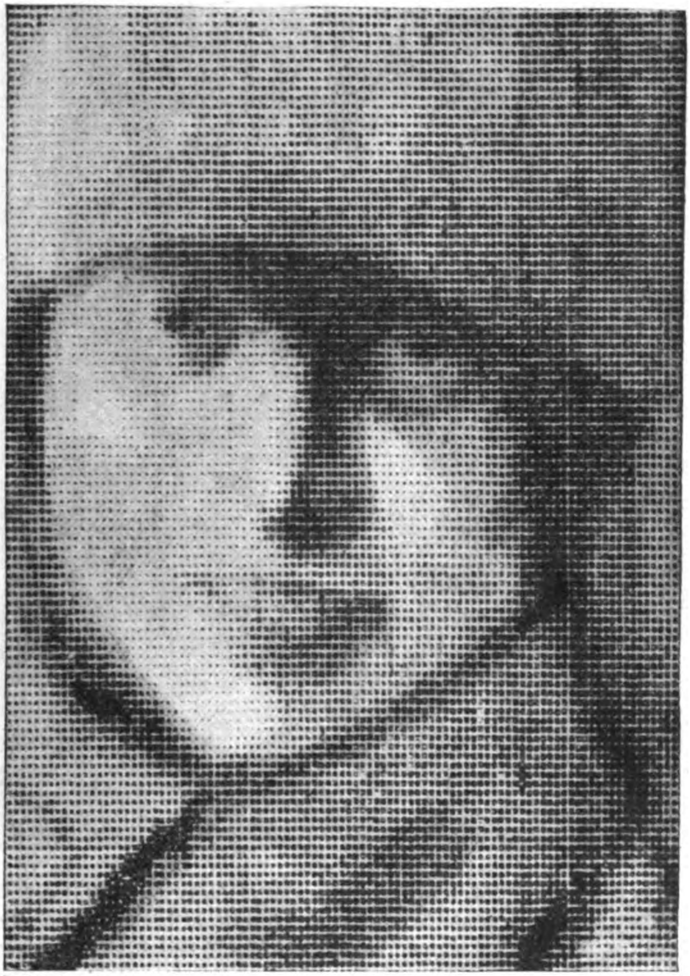
Pacific & Atlantic

The FIRST MAN TO SEND A PICTURE BY RADIO ACROSS THE OCEAN—*Dr. Korn, the inventor, transmitted a photograph on June 7, 1922, from Sanpaolo, Italy, to Bar Harbor, Maine. The apparatus translates the picture into a series of code letters, which are decoded at the receiving stations and printed on a typing machine that makes dots of varying intensity—as shown on the page facing.*

is a stylus attached to a flexible plate which makes contact for the electrical current. As the cylinder that bears the drawing turns, the stylus traces its way over the raised portions as the needle on a phonograph explores the depressions in the wax record.

Every time a line or raised point comes under the delicate stylus, the flexible plate to which it is attached is depressed so that the current is broken. Through this simple make-and-break device the blank or raised portions of the paper are translated by interruptions in the current and the white background by the current.

At the receiving end there is a cylinder, similar to that in the sending apparatus, which is encased in an octagonal shield. On this cylinder is wound a photographic film ready to receive the picture. As this cylinder turns on its axis it also moves past a microscopic opening in the shield through which the light must be registered on the film at one tiny point at a time.



Pacific & Atlantic

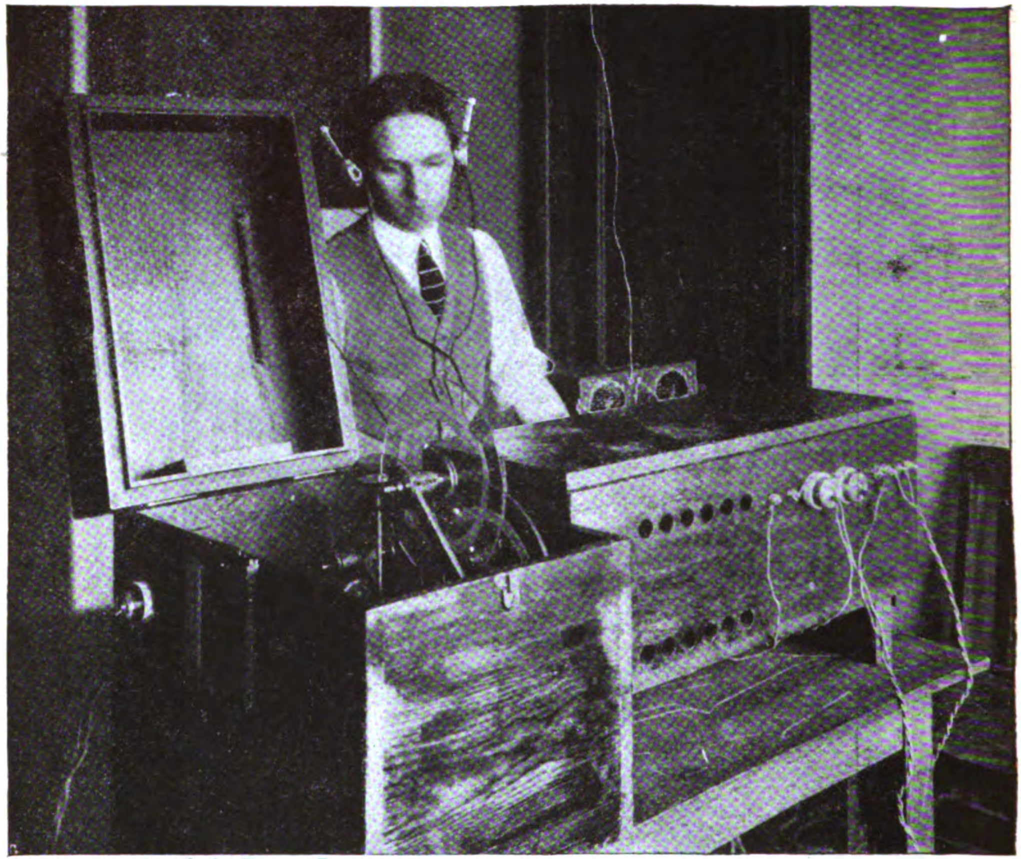
—AND A SPECIMEN PICTURE AS IT IS RECEIVED

The numerous dots of varying degrees of black correspond to code numbers; this picture is produced by typing the dots to conform with the code numbers. Less than 20 sizes of dots are used.

Now the transmitting device is sending only electrical current, and this cylinder in the receiving set is designed only to catch light. It is, therefore, necessary to translate the current into terms of light. To do this there is an ingenious contrivance. A small lamp is encased in a metal barrel and furnishes a constant source of light, the rays of which are converged by means of a lens onto a tiny mirror at such an angle that the beam of light will be reflected directly through the opening on the recording cylinder. Between the mirror and the recording cylinder, however, there is a little opaque screen in which is a single aperture.

The current coming over the wires or by radio tilts the mirror so that the beam of reflected light strikes the opaque screen and does not pass through the aperture in it. With the break in the current, the mirror swings back to the original position and sends its reflected ray through the opening in the screen and the microscopic hole in front of the revolving cylinder carrying the sensitized film.

In this simple black and white system



From a photograph made for POPULAR RADIO

THE JENKINS RECEIVING SET IN OPERATION

Here the radio impulses are being re-translated into light beams and flashed across the screen, in the form of quickly moving lines, by the two rotating discs—thereby re-creating the picture with lightning-like precision.

there are just two positions of the mirror so far as the receiving film is concerned. One in which it strikes the opaque screen and makes no record and one in which the reflected light is thrown through the aperture.

As the little mirror oscillates rapidly with the variations in the current and as the receiving cylinder with its sensitized film turns, a continuous spiral of exposures is made on the film and the separate turns in this spiral are so close together that to all intents and purposes a solid photographic negative is obtained.

A photograph is sent and received in practically the same way. A carbon print of the picture is made in the usual manner and this is wrapped on the cylinder. The cylinder is then placed in hot water with the result that the gelatine of the print adheres to the cylinder in accordance with its own degrees of blackness while the unexposed gelatine is washed away with the paper. In this way a coat of uneven thickness is obtained on the cylinder, thus forming a low relief of the photograph.

These variations in the surface of the sending record are translated into variations in the intensity of the current as in the case of black and white matter. At the receiving end, the little mirror now tilts in accordance with a greater number of current variations. Obviously, the opaque screen permitting the light to pass through or be shut out from the recording cylinder entirely can no longer be used. In its place, a screen of graduated transparency is employed; that is, it varies from opacity at one end to transparency at the other, and the intensity of the beam of reflected light which filters through it and is converged by means of another lens onto the sensitized film depends upon what part of this screen it strikes. The variations of the surface of the sending cylinder are translated into variations of current intensity which vary the tilt of the mirror correspondingly and the screen varying the intensity of the light which makes the record.

Dr. Arthur Korn, professor of electrophysics at the Berlin High School of Technology, is the inventor of a process of transmitting photographs that depends upon reducing the picture to dots that can be coded and sent over telegraph wires or radio like any other message. The New York *World* recently reproduced such a photograph sent from Rome to Bar Harbor, Maine.

Prof. Korn, on analyzing photographs and half-tones, realized that for practical purposes all the values of light and shade could be reproduced with from 15 to 20 sizes of dots. He took the different sizes of dots and gave to each a letter.

The machine which does the coding is quite complex. The Korn apparatus uses a point of brilliant light traveling over the photograph, being cut on and off rhythmically by a commutator in such a way that it strikes the picture at accurately spaced points. An ordinary cabinet-size photograph receives the light at about 1,000 points. The light passing through the negative falls upon a selenium light-sensitive cell, the quantity which passes through depending on the darkness or lightness of the film at that point.

The cell is placed in the transparent cylinder on which the negative is coiled, and as the latter slowly revolves the light that passes through the negative falls on the selenium. A current of electricity from a battery passes through the selenium, and its resistance is varied by the values of the light.

Each variation of resistance—of which in this case there would be seventeen—controls a key which drops to print a letter on a tape the instant it is actuated by the electric current, and the latter corresponds to the particular shade of the photograph.

In "coding" a picture about 1,000 letters are used. These are grouped by spacing into about 300 "words" which are sent by radio or by telegraph to any place. They are received by an ordinary telegraph or radio operator or by an automatic telegraphic receiving apparatus.

To decode or turn this word message back into a picture a Korn decoding instrument is necessary. This is a form of typewriter into which a sheet of paper about twelve by fifteen inches in size is placed. With the printed message before him the operator copies it on the keys; these, however, do not print letters, but dots of the sizes and shapes corresponding to the letters. As the code allows for the blank spaces between the dots the result is a very much enlarged half-tone reproduction of the original photograph.

In speed transmission the Jenkins apparatus appears to be far superior to both of the other methods that have been described. While the Belin and Korn methods may be used for commercial transmission of still photographs, it is difficult to imagine their use in the transmission of motion pictures by radio. But a complete picture in one-sixteenth of a second by the Jenkins apparatus does bring motion pictures and vision by radio into the realms of the possible. Mr. Jenkins also claims that his apparatus is the first that can send and receive a flat picture, a requisite to the perfection of seeing by radio.

It is hard to restrain the imagination when the perfection of the Jenkins process is assumed.

Kadel & Herbert

VARIATIONS OF THE "MAGIC BOTTLE OF RADIO"

The large tube, A, is used for transmitting; the small tube, B, is used for receiving only. Both, however, operate on the same principle and both contain the same three essential elements—a filament, a grid and a plate.

How the Vacuum Tube Works

ARTICLE NO. 1; HOW IT DETECTS AND RECTIFIES

This series of articles is designed to explain to the novice, in non-technical language that the layman can understand, some of the basic principles of radio phenomena

By ALFRED M. CADDELL

A NEWSPAPER man once interviewed a doctor who had evolved a highly scientific system of diagnosis. Said the scribe, "I'd like to have you tell me about it."

"All right," agreed the medico. And he did. But he kept going on and on—finally putting a capstone on his explanation by observing:

"That is it; now do you understand?"

Whereupon a returned-from-vacation look came into the reporter's eyes and he replied:

"Well—er—I did until you commenced to talk about it!"

A similar situation exists today in radio. Many of the most common phenomena are not really understood by the layman at all. Take the vacuum tube, for instance—the device that everyone has had more or less of an introduction to and which is also known variously as the "electron tube," "triode," "thermionic valve," "heart of radio," "Aladdin's lamp" and a half-dozen trade names for good measure.

Let us see if we cannot strike up a democratic acquaintance with it and explain its action in simple, understandable terms.

Like the doctor, the radio engineer is so thoroughly versed in technical nomenclature that he naturally dresses his explanations in plots and curves with a technical preciseness that is bewildering.

"A tube," says he, "is an invaluable device, consisting of a highly evacuated glass bulb in which there is a filament, grid and plate. The filament, which is energized by the 'A' battery, throws off electrons which are attracted to the plate by a positive charge delivered by the 'B' battery. In their travel from the filament to the plate, the electrons are intercepted by the grid, which acts as a valve for radio frequency impulses. If the grid is made positive with respect to the filament, the plate current is increased, and if it is made negative, the plate current is decreased. The grid voltage is thus very effective in controlling the electrons flowing from filament to plate, as will be seen by the accompanying curve. Assuming that the grid potential is at A, and a sine-wave voltage impressed on the grid by the antenna circuit, as shown in Figure 21"—and off he goes!

All that is very well—and highly useful to readers who can follow him. But for the beginner, a clear conception of what takes place within the vacuum tube is more difficult to get. High and low vacuua (hard and soft tubes), evaporation of electrons, grid potential, voltages, negative and positive charges, saturation points and the like are terms he does not really comprehend.

So in order to understand the delicate action of this twentieth century marvel, we will have to liken it to something familiar in everyday life.

In this first article, then, we will democratize the vacuum tube's more simple function of detection or rectification—and do it in terms that the layman can understand.

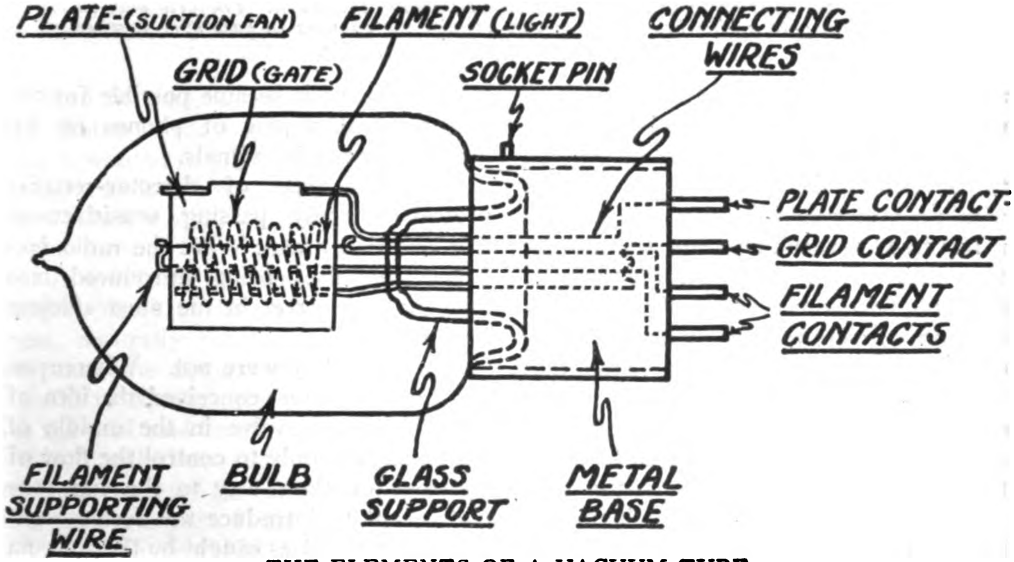
In the second article we will explain regeneration or "feed-back"; in the third we will explain amplification (cascade), and in the fourth we will explain high-frequency oscillation.

LET us imagine the vacuum tube as a street running from east to west. Let us imagine it as a *one-way street*, in which traffic can move only in one direction.

Let us imagine that this street has been completely housed by glass and all the air pumped out of it, leaving a vacuum.

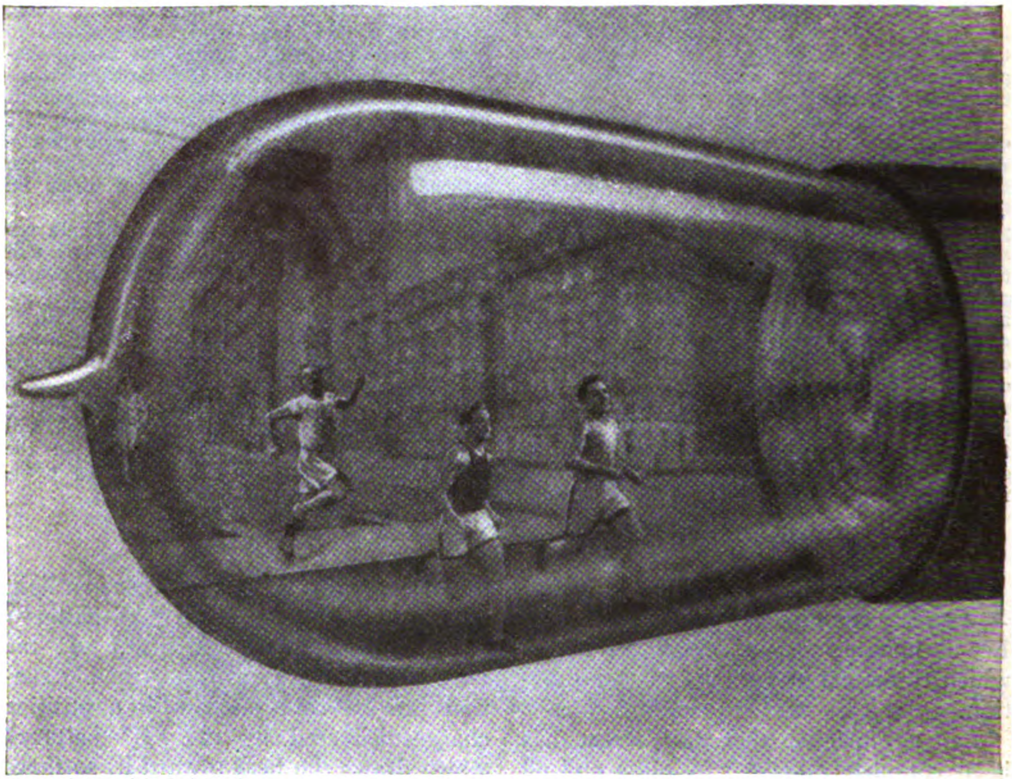
At the east end of this street is a light (a filament lighted by an "A" battery) that radiates continuous heat. At the west end of the street is a great big suction fan (a cold plate with a positive charge delivered by the "B" battery) which draws the heat toward it, so there is a one-way flow of heat in this street.

Then let us imagine this flow of "heat"



THE ELEMENTS OF A VACUUM TUBE

Here are shown the various parts of the tube—the cylindrical plate, the spiral grid and the filament, together with the other structural details of a tube which may be used as a detector of radio impulses.



From a photograph by J. A. Weeks

When the Grid Is POSITIVE

The tube may be likened to a one-way street at one end of which is a suction fan (the plate) which is drawing the runners (the electrons) toward it. The grid may be likened to a gate, which lies prostrate and permits the runners to pass over it when it is charged with positive electricity.

as a flow of electrons, and we get a general idea of what takes place in the tube.

This flow of electrons was discovered to be very sensitive to changes. It met with no atmospheric resistance, because it traversed a vacuum; there was no gas to ionize. Prof. James A. Fleming, of England, first employed this flow of electrons in wireless telegraphy as a detector of weak radio signals. He found that when radio frequency impulses,* intercepted by the antenna, were led into this tube or "street" through the filament, they were drawn through the suction fan (the plate) at the other end, where they become rectified and strengthened. By this means it became possible for the listener with a pair of phones on his head to hear radio signals.

But this type of detector-rectifier proved of only passing sensitiveness. The question arose: Were the radio frequency impulses being introduced into this one-way street in the most efficient manner?

Evidently they were not. Whereupon Dr. Lee De Forest conceived the idea of installing a gate-valve in the middle of the street, not only to control the flow of electrons on their way to the fan (the plate), but to introduce the feeble high-frequency impulses caught by the antenna through the gate, so that a more sensitive action would result.

This De Forest gate was a most pecu-

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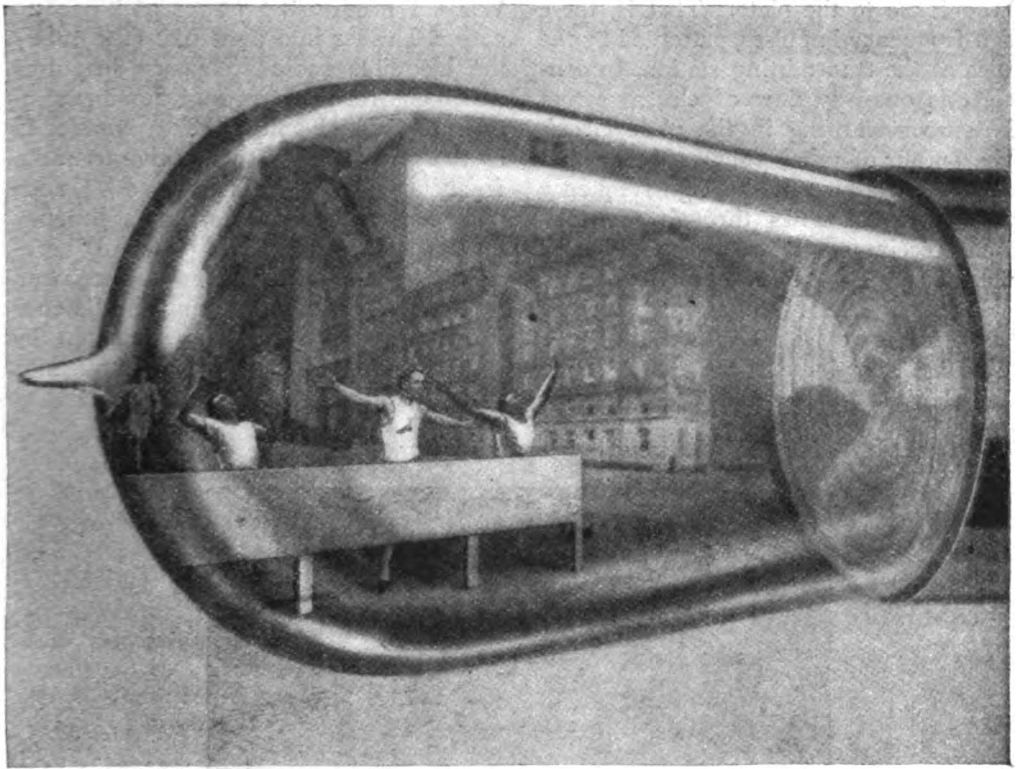
*Radio frequency impulses are electrical impulses that vibrate too fast—at the rate of more than 20,000 a second—for the ear to hear; audio frequencies lie below 20,000.



From a photograph by J. A. Weeks

When the Grid Is NEGATIVE

When the gate is charged with negative electricity, the gate (the grid) rises to block the runners (the electrons), thus decreasing the number of runners who get through to the fan. The electrons that reach the fan (the plate) vary in number with the voltage changes in the gate (the grid).

liar kind of gate, constructed of imaginary shutters (varying polarity), so that when it wanted to allow electrons to pass through, all it did was to open the shutters. When it didn't want the electrons to get through it simply closed them. Bear in mind that the fan (the positively charged plate) at the other end of the street, naturally wanted to get all the electrons (the negative electricity) that it could to equalize the electric charges. But the grid said in effect:

"No, I will allow you to have the electrons only as I see fit. I, too, have a mission to perform. I am an automatic radio frequency valve, connected to an antenna circuit which intercepts voice-controlled (or modulated) radio waves. It is my duty to bring them into the street so that they will control the one-way stream of electrons flowing therein

"These radio impulses that come through me are made up of successive positive and negative charges of electricity and inasmuch as electrons flow only one way in this street—there is a flow of negative electricity only — the negative half of the radio frequency impulses that come in through me repels the negative stream of electrons from the filament. Thus the negative frequency impulse causes my shutters to close, preventing the passage of electrons to the plate.

"But," continues the De Forest gate, "when the radio frequency impulse is positive (and every other one is), it causes my shutters to open, and the electrons dash off the filament and pass through me to the plate. That is, these high-frequency impulses, patterned by the voice at the transmitting station, so control this one-way flow of electrons that the current flowing in the plate circuit (the output of tube) follows the general contour variations of the high-frequency carrier waves, flows through the telephone receivers and produces diaphragm vibrations. And these vibrations push and pull the surrounding air, causing sound waves to be produced.

"Thus," emphasizes the gate, "I am the absolute master of the situation. While I produce no power and use no power, I usher into the street (the tube) the inaudible radio frequency impulses which control the stream of flowing electrons. Thus the flow, being controlled by the grid which is so sensitive to radio frequency variations, is caused to rush and stop, rush and stop, in its journey from the filament to the plate. Whereupon, by the aid of phone receivers, sound waves are created and the listener hears the message that was spoken by someone who was hundreds or thousands of miles away."

Harris & Ewing

UNCLE SAM DESIGNS A SPECIAL HOME-MADE RECEIVER FOR HIS LIGHTHOUSE KEEPERS

No one who has not actually lived in a lighthouse and experienced this form of isolation can fully appreciate just what radio means to the men of this branch of the service. The Bureau of Standards has just issued detailed instructions for the building of a set that is especially adapted for this purpose; it contains three spider-web coils, condensers, a 1½-volt tube that operates on a dry cell, and a "B" battery. The set is self-contained, and requires only a short antenna and a pair of headphones.

From a photograph made for POPULAR RADIO

HOW TO MAKE A SIMPLE

SINGLE TUBE RECEIVING SET

In this article the radio novice—who has reached the point where the crystal set no longer meets his needs—will find complete, detailed directions for building a really efficient receiver that is selective and economical to operate. The set may be built by any beginner at a cost of $25.00 or less.

By LAURENCE M. COCKADAY, R.E.

MOST beginners in radio who build their first tube set experience a great amount of trouble. Usually they have to call in outside assistance before the set is made to work at all.

The reason is that most beginners start out with a too complicated set and consequently make an inordinate number of mistakes. This little set here described is simplicity personified; indeed, one of its best features is the fact that the builder can easily make the coils himself and thereby get the best possible kind of experience. The whole set should not occupy more than three hours to complete, exclusive of the time spent on the cabinet. The set may be used with the ordinary vacuum tube or with a tube that runs on a dry cell, thus doing away with the storage battery. Either tube may be used with one or two small sized 22½-volt "B" batteries.

The set will tune sharply, in spite of the fact that it has such a simple wavelength control. It will tune from 170 meters to 520 meters, which takes in the amateur band of wavelengths and the broadcasting between 360 and 400 meters and the ships' stations on 450 meters.

The set will give best results with a single wire antenna approximately 100 to 150 feet in length, with a ground for the set on a waterpipe. The electrical circuit diagram is shown in Figure 1.

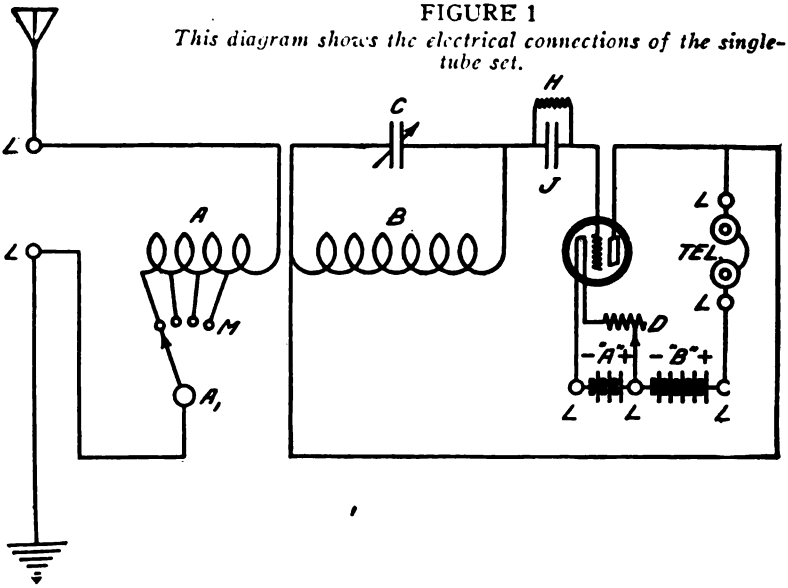


FIGURE 1
This diagram shows the electrical connections of the single-tube set.

The Parts Used in Building the Set

In the diagrams in this article each piece of apparatus bears a designating letter; in this way the builder may easily determine how to mount the instruments in the correct places and how to connect them properly in the electrical circuit. The same designations are used in the text and in the list of parts below. This list includes the exact instruments used in the set from which these specifications were made up; however, there are other reliable makes of instruments which may be used in the set with excellent results. If other instruments than those listed are used, the only changes necessitated will be in the different spacings of the holes drilled in the panel for mounting them.

A—tapped primary winding, consisting of 45 turns of No. 18 S. C. C. copper wire.
B—secondary winding, consisting of 65 turns of No. 18 S. C. C. copper wire. (A and B are wound on a composition tube 3½ inches in diameter and 5¼ inches long.)
C—variable condenser .0005 mfd. (This condenser may be any reliable make in which the spacing between the edges of the rotary and stationary plates with the plates "all outs" is at least one quarter of an inch. In other words, a condenser with a low minimum capacity.)
D—filament rheostat, 5 ohms.
A1, C1 and D1—antenna switch knob, secondary tuning condenser knob and rheostat knob, respectively.
E—socket.
F—shelf panel, see Figures 2 and 3, 4 and 6.
G—brass angles for supporting the socket shelf. (See Figures 2, 3 and 4.)
H—grid leak (tubular), 1 or 2 megohms.
I—small phosphor-bronze angles for mounting grid leak. (See Figures 2 and 6.)
J—mica grid condenser, .00025 mfd. (This may be purchased or built according to specifications in the article on page 124 of the October, 1922, issue of Popular Radio.)
K—phosphor-bronze contact fingers, for sockets. (See Figures 2, 3 and 4.) A regulation socket may be used instead of E and K.
L—binding posts.
M—switch points. (See Figures 5 and 6.)
N—small brass brackets. (See Figures 2, 4 and 6.)
O—peep-holes viewing the filament of the vacuum tube. (See Figures 5, 6 and 7.)
P—composition panel on which the instruments are mounted.
Q—cabinet, made of hard wood.
R—taps on the primary coil for antenna tuning. (See Figures 3 and 8a.)

How to Construct the Set

After all the instruments for building the receiver are procured, the amateur should set about preparing the panel P shown in Figures 3, 5, 6 and 7.

First of all the panel should be cut to the correct size (9 by 10 inches); then the edges should be squared up smoothly with a file. The centers for boring the holes which are necessary for mounting the instruments should be laid out on the panel as shown in Figure 7. The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull, permanent finish will be the result. Or, the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, the condenser C should be mounted in the lower left-hand corner by means of two screws fastened through the panel, as shown in Figures 4, 5 and 6. The large dial (C1) should then be fastened to the shaft of the condenser as shown in Figures 4 and 5.

The rheostat D should then be mounted in the proper place with two screws (see Figures 3, 4 and 6), and the small dial D1 should be attached to it. (See Figures 4 and 5.)

The seven binding posts L may then be inserted through the panel and fastened tight by means of nuts on the rear of the panel P, as shown in Figures 3, 4, 5 and 6.

The next step is the preparation of the shelf assembly F. This shelf panel should be cut to the correct size (see Figure 2) and should have two brass strips G (Figure 2) fastened along its sides as shown in Figures 3, 4 and 6.

A square hole should be made in the shelf (as shown in Figure 2) for the socket, and the holes for the screws which secure the contact fingers K to the shelf should be bored and tapped. The fingers K are then fastened in place on the under side of the panel and the socket spinning E should be screwed down on the top of the panel F by means of two screws, as indicated in Figures 3 and 6. As an alternative, an ordinary socket may be used and secured to the shelf if the builder does not wish to make the socket himself.

The two phosphor-bronze spring contacts I for mounting the grid leak may now be made

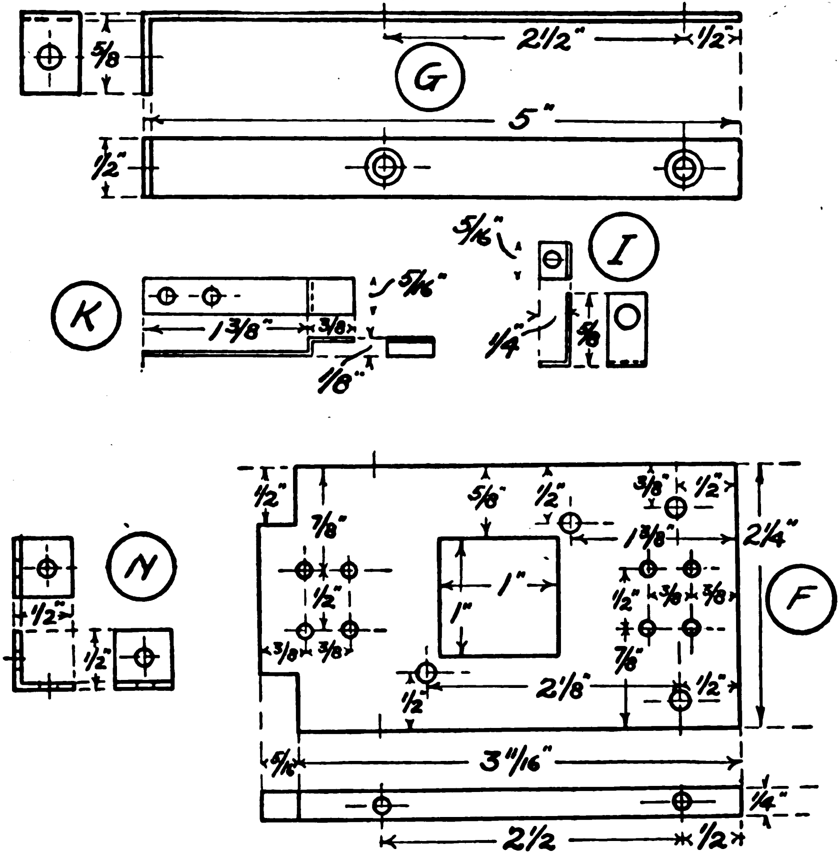


FIGURE 2

This diagram shows the dimensions of the metal brackets and contacts; also the correct shapes for bending. Pieces G and N are 1/16-inch brass. Pieces K and I are of springy phosphor bronze. Four of K are used for the socket contacts, two of I for mounting the grid leak, and two of G for supporting the shelf. The shelf should be made and drilled as shown at F.

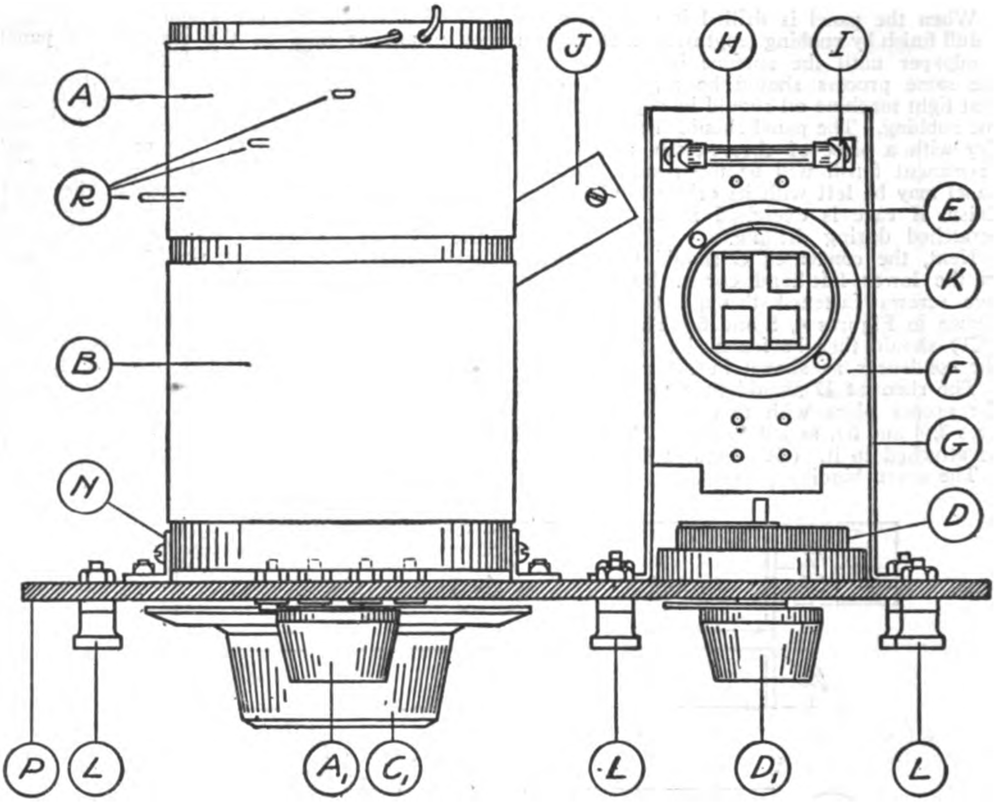


FIGURE 3

Top view of the set, showing the structural details for mounting the coil tube, the rheostat and the vacuum tube shelf. The binding posts are inserted through the panel and fastened tight with brass hexagon nuts. The condenser J is supported by the wiring itself.

(see Figure 2) and fastened as shown in Figures 3, 4 and 6. The grid leak H should be inserted in the two holes made in the contacts I for that purpose.

Mount the shelf F on the main panel P by means of two screws through the brass brackets G and the two holes in the panel on either side of the rheostat knob D1. The flathead screws are inserted through the panel and fastened on the rear by brass nuts, as shown in Figures 3, 4 and 6.

The next step is the preparation of the shelf tuner elements, consisting of coils A and B.

Start by cutting the insulating tube, which is 3½ inches in diameter, to a length of 5¾ inches. Bore two small holes a quarter of an inch apart in a line at right angles to the axis of the tube about ½-inch from one end of the tube. The holes should be just large enough to pass the No. 18 S. C. C. copper wire.

Now thread one end of the wire through one hole from the outside of the tube and then back through the other hole to the outside again, as shown in Figure 8b, and proceed to wind on 65 turns of wire that comprise the secondary coil B. Two more holes are then bored at the finish of this winding and the winding is terminated in the same manner as it was begun, by threading through these two holes.

One quarter of an inch beyond the last two holes bore two more starting holes for coil A and proceed in the same manner as with coil B, except that four taps are taken off, one at the 15th turn and one every 10th turn thereafter, as shown in Figures 3 and 8b; finish off in the same way as with coil B.

Leave the four end wires long enough for connections when the set is being wired; about six or eight inch lengths. The method of making a tap is shown in Figure 8a.

Now make the small brass angles N, as shown in Figure 2, and fasten the tube to the panel P. (See Figures 3, 4 and 6.)

Next, insert the four switch points M through the panel P and fasten with nuts on the rear of the panel. (See Figures 5 and 6.) The antenna switch knob A1 is fastened in place as shown in Figures 3, 4 and 5 and then the assembly work is complete except for making the grid condenser J. (Complete instructions for doing this were given in the

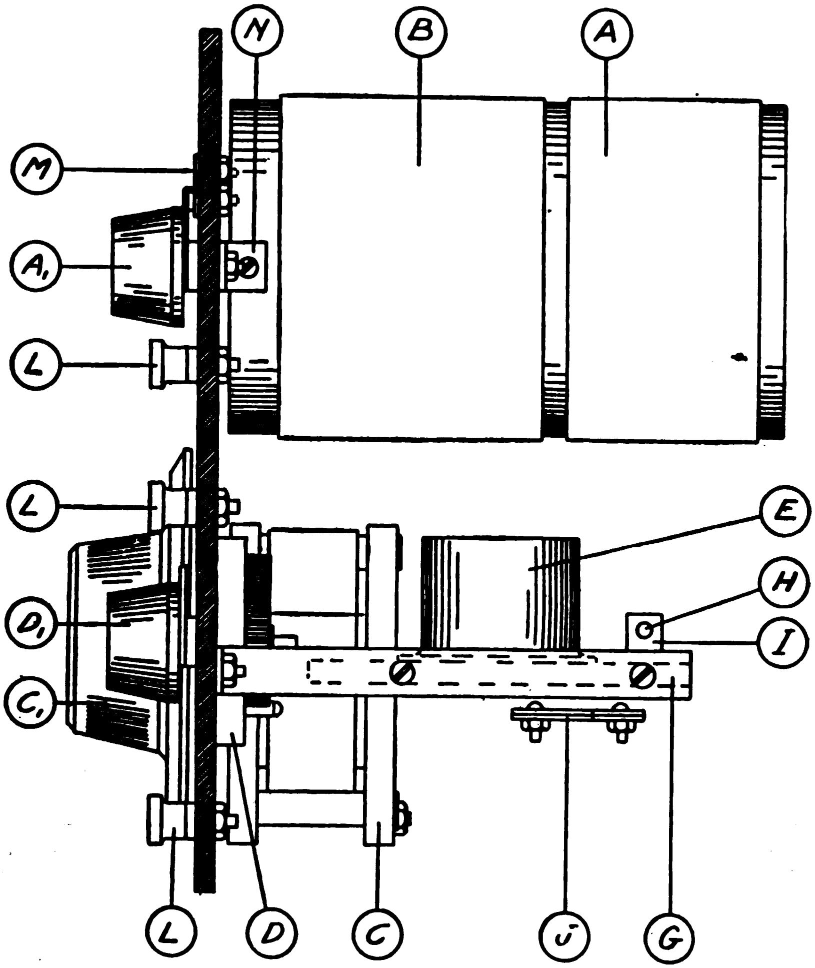


FIGURE 4

View of the set from the right side, showing how the shelf is fastened to the two brass brackets G by two screws which are threaded into the edge of the composition shelf. The coils are supported by means of two small brackets N.

October issue of POPULAR RADIO on page 24.)

It is much better to use mica dielectric condensers than the paper condensers. Any good mica grid condenser of .00025 mfd. capacity is suitable. The grid condenser is supported in place by the connecting wires.

A cabinet for the set may be obtained from a cabinetmaker at a reasonably small cost. Give the cabinet man the diagram in Figure 9 and ask him to make it of hard wood.

How to Wire and Connect the Set

Start by wiring the filament circuit and the "A" battery connections from the diagram in Figure 1. A good method for the beginner to follow is to select a connection running between two instruments on the diagram and wire up this connection in the set. When this is properly done, trace the same line over on the diagram with a colored pencil and you will know that that wire is completed correctly. If the same procedure is followed with all the rest of the connecting wires in the set you will have a sure check that nothing has been left out and no wrong connections have been made—all the connections on the diagram will have been covered with a colored pencil mark. If you have forgotten some detail, the omission will show on the diagram, as it will not be covered by a colored pencil mark.

When the filament circuit is completed connect the coil A to the antenna switch A1 by running the taps in through the end of the coil and soldering to the switch points M. (It may be necessary to loosen the tube from the panel to do this.) Then connect the antenna and ground binding posts as shown in Figure 1.

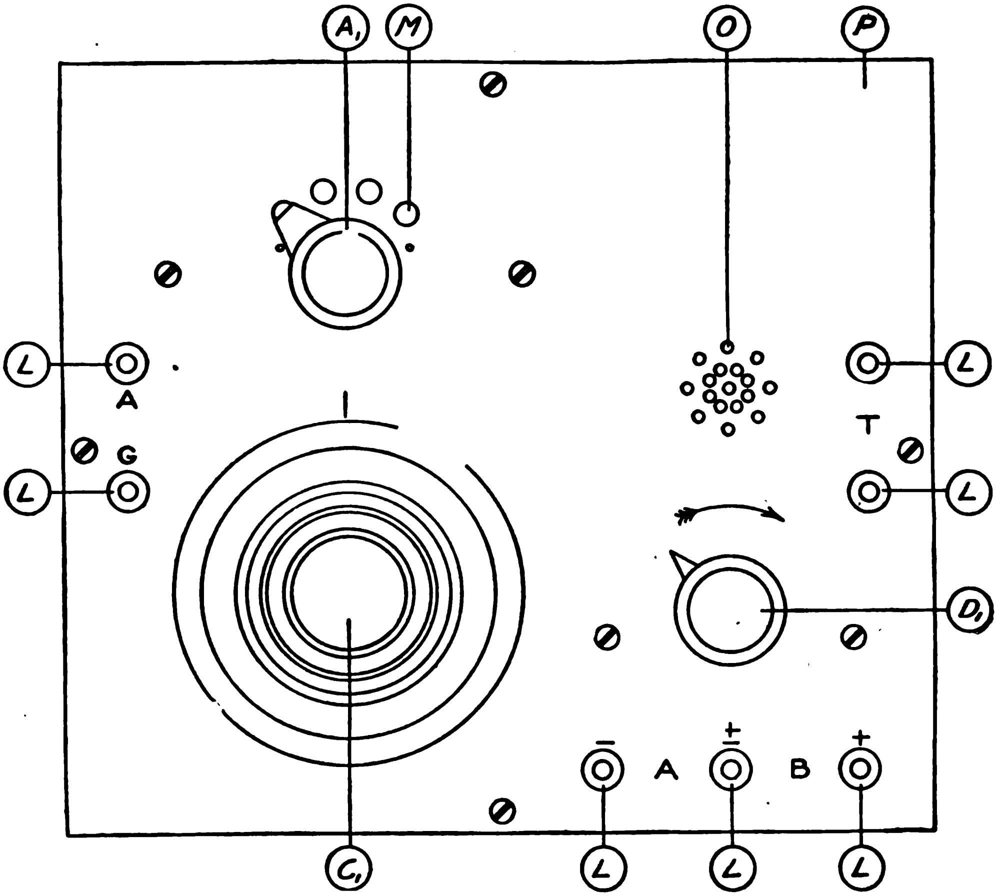


FIGURE 5
The layout for the front of the panel. This is the way the set will look when completed, provided the holes for mounting the instruments are drilled as shown in the diagram in Figure 7.

Next, wire up the secondary coil B to the vacuum tube grid and plate circuits, including the two binding posts L at the right side of the set (looking at the front of the set) in series with the plate of the tube. These two posts are for the telephones. The three binding posts at the bottom of the set are for the batteries. The "A" battery is connected between the outside left-hand post and the middle post, with the *positive* terminal on the middle post; and the "B" battery is connected between the outside right-hand post and the middle post, with the *negative* terminal on the middle post. (See Figures 1 and 5.)

The antenna and ground connections are made to the two binding posts at the left.

Operating Data

The following hints may be of value:

The set may be used with almost any type of antenna which has a horizontal length of over 75 feet, although, as stated before, a 100-foot single wire will be found best. It is best to use a water pipe for a ground.

To operate the receiver, turn on the filament of the tube by revolving the knob D1 in a clockwise direction until the correct filament brilliancy is obtained. Set the antenna switch A1 on the correct contact point for the wavelength on which you wish to receive (this will depend on the length of your antenna and should be determined by experience); and rotate the knob C1 until the desired signals are heard. Final adjustment with the filament knob D1 will boost up the strength of the signals to a maximum.

It should be remembered that the tuning with the dial C1 is very critical and the dial should, therefore, be rotated slowly and carefully. The amateurs tune somewhere between 0 and 15 on the scale and the broadcasting stations somewhere between 20 and 40. Ships tune in between 90 and 100 on 600 meters.

This set may be used with either a soft or hard six-volt filament tube and battery, or it may be used with a WD-11 1½-volt fila-

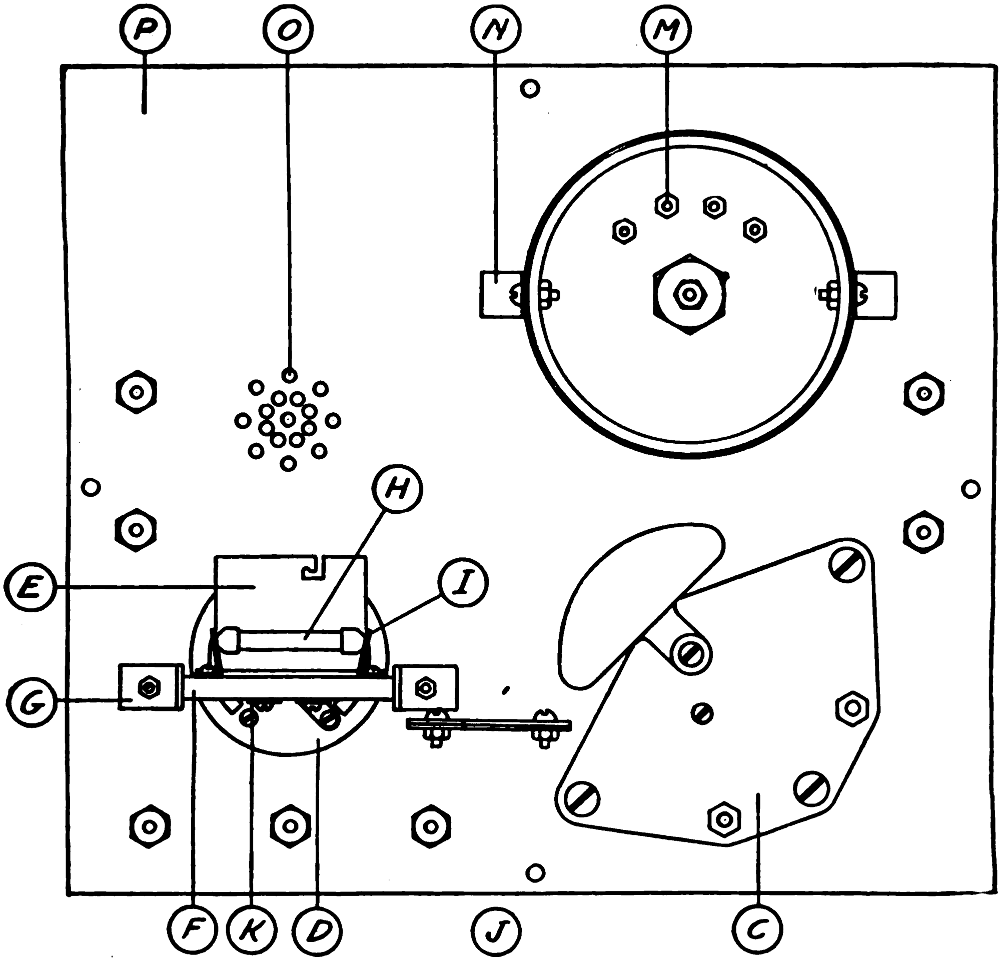


FIGURE 6

The rear view of the panel. The condenser C is mounted directly underneath the coils A and B, with the socket shelf right alongside of it. This arrangement does away with long connecting-wires which are a detriment to tuning efficiency in a set.

ment tube and a dry cell. The latter tube is recommended in case this is the beginner's first set, as it will run on one dry cell for a considerable length of time. If this tube is used it will require an adapter for fitting into the standard socket. This adapter is shown in Figure 10.

The set combines low price, simplicity of construction, sharp tuning, with a good distance range, and anyone *can* make and operate it.

You can do it!

HINTS FOR THOSE WHO BUILD THIS SET

DON'T rush at this job and make the set with any makeshift parts that you happen to have on hand.

DON'T do a sloppy job on the set; it is a simple piece of apparatus, and you should take pride in doing it well.

READ this article over two or three times before even deciding to make the set; in this way you will get a better idea of the task and be able to plan out just what you need in the way of supplies if you do decide to make it. Read the article through carefully enough times to become familiar with the design and construction.

Go over the list of parts and check off the material you may have on hand already.

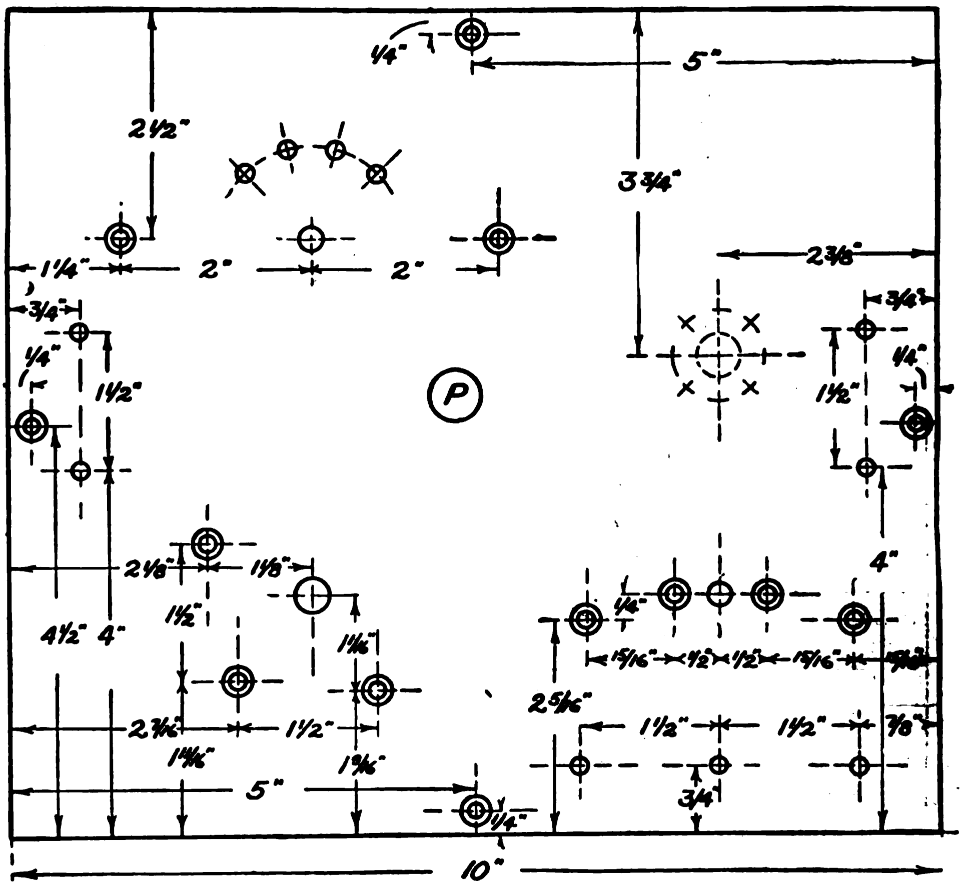


FIGURE 7

The above drawing gives the details for drilling the panel P. The holes outlined with a double circle should be counter-sunk so that the flathead screws will be flush with the panel surface.

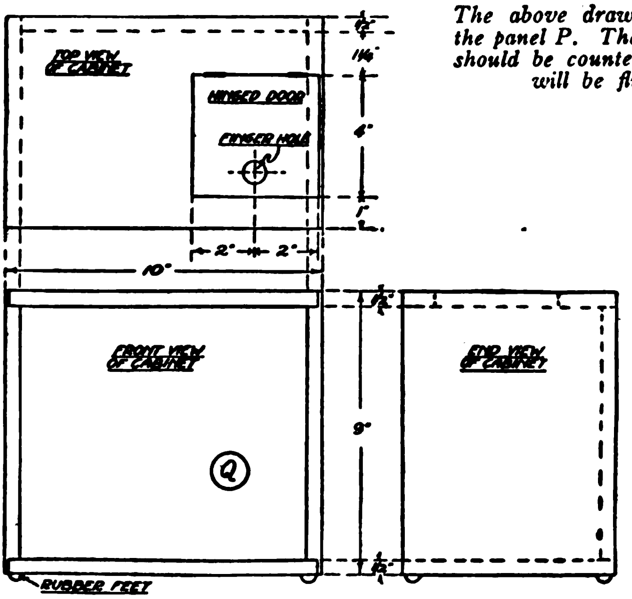


FIGURE 8

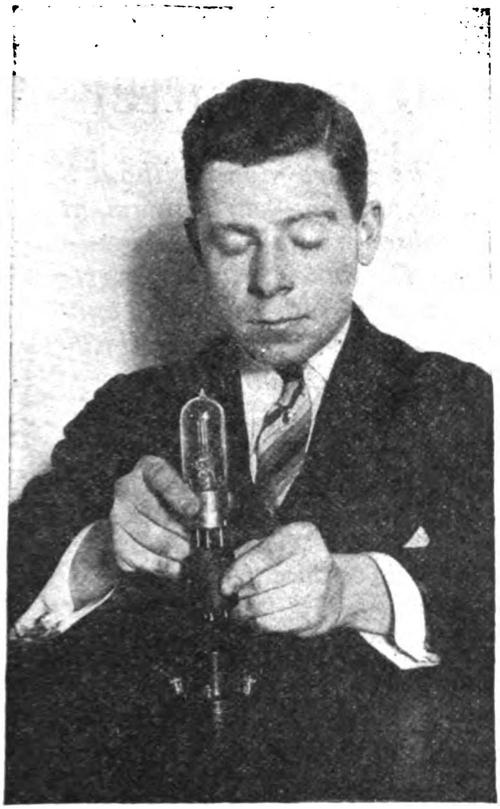
The dimensions for the cabinet. Give this drawing to a cabinet maker and have him do the work for you.

CONSULT our advertising columns for the apparatus you have to buy.

AFTER getting all the parts, re-read the article again and get all your tools together and everything in readiness for the job.

START building the set exactly as the operations are described in the article, starting with the preparation of the panel and finishing with the wiring, and *sticking to details all the way through.*

IF you are a beginner you will probably take at least a week to learn how to tune the set to get good results and even from that time on the set will seem to improve and you will reach out for greater and greater distances. This means that you will have been learning to tune it better and better. Learning how to tune a radio receiver is something like learning how to ride a bicycle. It takes practice and concentration, but when you have the knack, you do it without thinking.



THE ADAPTER FOR THE 1½-VOLT TUBE

The tube is pushed into the adapter and then the adapter is inserted in the socket in the same manner as an ordinary tube.

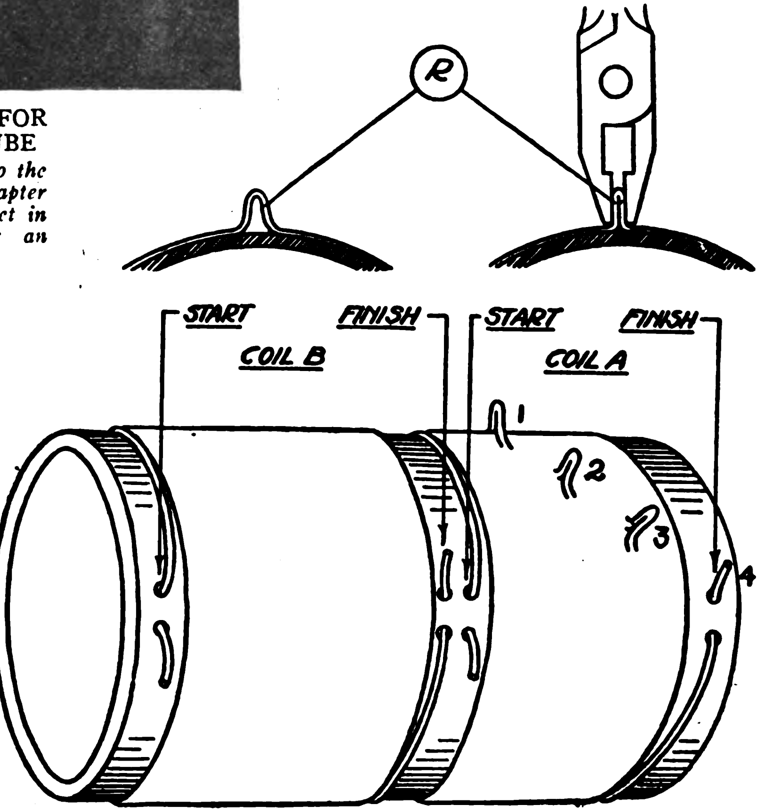


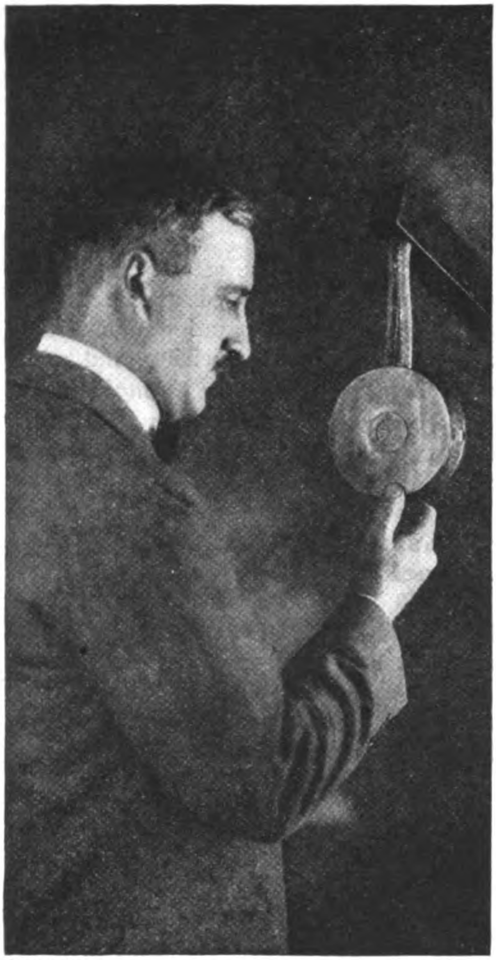
FIGURE 9

The top part of this diagram shows how to make a tap. It is squeezed together with the pliers after the coil is completed. The lower portion of the diagram shows how the coils are started and finished.

THE REMARKABLE NEW "Glow" Transmitter

The microphone without a diaphragm—an instrument which contains no moving parts and which converts sounds into electric currents by means of a vibrating column of ions

By DAVID LAY



Westinghouse

THE "PILLBOX" MOUNTED IN ITS CASE

The inventor, Dr. Phillips Thomas, is a consulting engineer, who is a member of half a dozen learned societies and a former Major in the Chemical Warfare Division of the Army.

A CONCERT over the radiophone ought to be heard as perfectly as though the listener were actually present in the concert hall. That is the ideal. There is a good chance that it will soon be a reality. We need only a few more improvements as successful as the new glow discharge transmitter* devised by Dr. Phillips Thomas of the Westinghouse Research Laboratories.

I saw this transmitter a short time ago at KDKA, the Westinghouse broadcasting station at East Pittsburgh. I heard it work. Unless I am much mistaken, it is destined to be one of the four or five important radio inventions, perhaps the single one which will add broadcasting to the permanent amusement *repertoire* of the United States.

The new transmitter looks like an ordinary drugstore pill box. You could put half a dozen of them in your pocket. One end of the pill box is open, or rather this end is closed only by a fine-mesh screen, to keep out the dirt. Inside the box you see a little glittering point of light. This is the bright spot at the negative end of the discharge. You talk at the pill box and every tone and inflection of your voice goes out with the broadcast wave. You play music at the pill box and the music goes out; goes out exactly, every overtone and shade of tonal color reproduced precisely as it was played.

If you have been listening in on KDKA lately, you have probably heard the new transmitter without knowing it. You have wondered, perhaps, why the music seemed to be so much richer and fuller on some nights than on others. That may have been, of course, because of better tuning of your receiving set or because of unusual freedom from static, but probably it was simply because Dr. Thomas was trying his transmitter.

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*Announced for the first time in POPULAR RADIO for March, 1923.

All tests have been successful and the transmitter will soon go into service as the only transmitter used at KDKA, for music, if not for all kinds of broadcasting. Thus will pass into history one of the great worries of the broadcast impresario; worry over how to seat his orchestra, how to balance and tune his instruments, how to coach his players in order to get even a passable result.

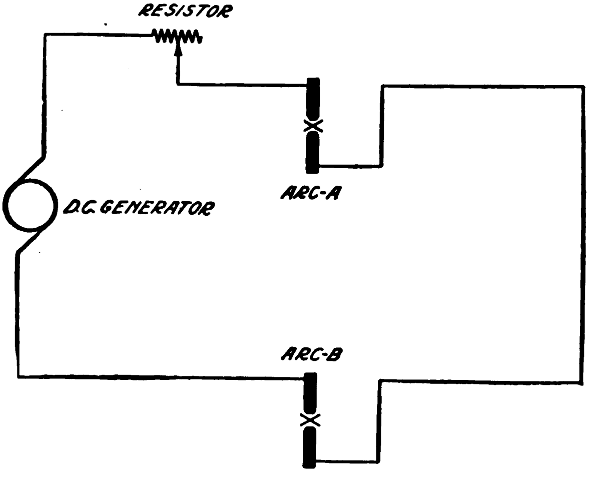
This broadcasting of instrumental music, especially of orchestral music, has always been extremely difficult. The orchestra produces too many kinds of tones. Not only do the tones range in pitch from the treble squeak of the piccolo to the growl of the double-bass, but they vary also in quality, in what musicians call "tone color." A note played on the clarinet, for instance, does not sound like the same note played on the cello. All of the minute variations in pitch and quality, the broadcaster of instrumental music must reproduce. He must contrive, somehow, to get each tiny shade of sound into the ether wave which carries his concert to the waiting audience.

With the usual types of transmitter this is worse than difficult; it is impossible. A transmitter which registers well enough the high tones of the wood-wind, usually fails on the deep tones of the brass or of the organ. One which reproduces successfully the moderate pitch of the human voice, fails both on the high tones of the orchestra and on its low ones.

This was the situation when the problem was tackled by Dr. Thomas and his associates.

A large part of the trouble they traced to the transmitter or microphone. Radio telephony requires two devices, neither of which is new. One of these is the transmitter, the other is the earphone used in the receiver. These have similar purposes. They change sound energy into electric energy, and *vice versa.* The transmitter picks up sound and converts it into electric energy. The earphone receives electric energy and converts it into sound.

The trouble with broadcasting heretofore has been that the transmitter did not do its part of the job very well. It has failed to convert the sound waves



THE PHENOMENA OF "THE TALKING ARC LAMP"

Electrical students will remember their laboratory experiment in which two arcs were connected in series with a generator and a resistor; when the arc A was spoken into, the arc B (which may have been located in another room) repeated the spoken word. Here was another case of sound waves that were picked up by means of an electrical discharge.

perfectly into electric waves. Some kinds of sound, certain tones or over-tones, it would not convert at all.

The culprit in the transmitter is the diaphragm. All of the usual devices for converting sound into electric energy—the transmitter, the telephone, the microphones—operate by means of a vibratory diaphragm.

Consider the ordinary telephone transmitter. Inside the mouthpiece is a thin plate of metal. This is the diaphragm. When sound strikes it, it vibrates just as the windows will rattle from an explosion or from a deep and powerful organ note. The back and forth vibration of the diaphragm is changed into an electric vibration by means of a loose contact with a carbon button, or by an electro-magnet, or in some other way. The exact way does not matter. The important point is that there must be a diaphragm. And if the diaphragm fails to respond perfectly to each tiny vibration of the sound waves, the conversion of the sound into electric waves, its transmission by telephone or its broadcasting, will not be perfect.

Now this, as it happens, is exactly wherein diaphragms fail. They do not respond perfectly to the sound waves. It requires a certain amount of sound energy to make a diaphgram move, it requires a perceptible push against it, just as a cannon ball on a level table requires a push to make it move. This is the law of inertia. "Bodies at rest tend to remain at rest." When a sound wave hits the diaphragm it has to push the diaphragm in order to produce a vibration. If the sound wave happens to be a very feeble one it may be unable to push the diaphragm sufficiently. Right then that particular sound wave drops out. No wonder you cannot pick them up in your receiver. They have never even started toward you.

Another fault of diaphragms is their tendency to vibrate only in response to sound waves of a certain frequency or pitch; waves, that is, which have a certain number of vibrations a second. Any material substance which will vibrate in response to sound waves has a certain characteristic pitch to which it is naturally tuned, to which, as physicists say, it is resonant.

If two violins, side by side, have their A strings tuned alike, a note played on one A string will cause the other A string to vibrate and sound the same note. This is the phenomena of resonance, or sympathetic vibration. There is a story that Caruso, having ascertained the note of a wine glass by tapping it, sang that note at the glass with such intensity that the glass was shattered by its own resonant vibrations.

The diaphragm of an ordinary radio transmitter or of a telephone has a pitch corresponding to about 1,000 vibrations a second. This means that for a tone of this frequency the diaphragm will vibrate most easily. It will respond fairly well to tones not too far from this frequency; usually, for ordinary transmitters, to tones between about 200 to 3,000 vibrations a second. This is the approximate range of the human voice. For the speaking voice, therefore, this ordinary telephone repeats the tones well enough for practical purposes; in other words, the pitch range of the voice and of the ordinary sized telephone diaphragm are about the same.

But when we come to music this range is not enough. The highest note of the piano has over 3,500 vibrations a second. The orchestra goes higher (for instance the piccolo, on its highest D, reached a pitch of 4,750 vibrations a second). Some of the instruments, on the other hand, go too low for the ordinary diaphragm. The bass viol, the tuba and the bassoon go well below 100 vibrations a second. The deepest pipes of large organs go down to 16 or even to 8. For these extreme tones, both high and low, the ordinary diaphragm is worthless. It cannot pick them up at all; it cannot, so to speak, hear them. It fails to translate them into electric pulses and they

Westinghouse

A PRACTICAL TEST OF THE NEW TRANSMITTER IN THE STUDIO

Here the transmitter must register not only the thrilling tones of the soprano and the booming notes of the basso, but it must reproduce truthfully the hundreds of tone variations which are present in the music of an orchestra.

drop out of the music which is sent.

This was the situation which confronted Dr. Thomas. All existing transmitters worked by means of diaphragms. All diaphragms were bad in principle. At least they were not perfect. What was needed was a transmitter without inertia, and with the capacity to respond to all tones, regardless of pitch.

It did not seem likely that any diaphragm could be constructed to meet these conditions and so Dr. Thomas was bold. He threw the diaphragm away. He rejected altogether the principle of the diaphragm transmitter and set out after a new principle. He found it. It was the principle of the direct-current glow discharge, the principle which he uses in his new transmitter.

Twenty years ago physicists used to play about in the laboratory with an interesting scientific toy, the "talking arc lamp." You connected two direct-current arc lamps in the same circuit together with certain condensers and inductances. You talked at one of the arcs so that the sound waves from your voice hit against the flame of the arc. The other arc, connected in series with the one you talked at, repeated your words. The two arcs were put in different rooms, so that an arc lamp burning peacefully on the classroom table could be made to inquire about the football score or the trim of the professor's whiskers, much to the amusement of the embryo physicists.

Evidently the arc converts sound waves into electrical waves by variations of its arc length due to passage of currents of modulated air. Hence, since there was a definite mass of heated material in the arc stream, it took more energy to push through high notes than low, so that it had a slight frequency discrimination. It also took so much energy, all of which was converted into heat, that the electrodes burned away quite rapidly and it was impossible to prevent hissing and sputtering, either continuous or intermittent. The high temperature at the electrodes precluded the use of any pure metal alloy, which might have served to reduce the noises.

This new discharge transmitter is in no sense an arc. Its characteristics are all radically different from those of an arc. It is not in any sense a reversion to the ordinary speaking arc.

The new development is a means of utilizing the change in voltage-current characteristic of the massless portion of a glow-discharge ionization current, this change produced directly by air pressure changes in the current stream.

The glow discharge has two sensitive portions, the Faraday dark space and the positive column. The Faraday dark space is massless and is the portion used in the new transmitter.

The successful completion of this work required months of patient research and the perfection of a multitude of details. It was necessary to discover what voltage and amperage of the discharge would make it both permanent and properly sensitive to sound. It was necessary to find a satisfactory material for its terminals, a material which would neither burn out too fast, nor interfere with sound sensitiveness, nor produce bubbling or sizzling sounds of its own. It was found, among other things, that only half of the discharge was adequately sensitive to sound waves. The other half of it had to be shielded by a hollow insulating shield.

All these details have been worked out satisfactorily. The discharge is operated by direct current. The gap length is only a millimeter or two between terminals of a special alloy. The voltage used is about 3,000 volts, but the amperage is extremely low—so low that the high voltage constitutes no danger to life. Tests with the discharge as a transmitter have shown perfect conversions of sound vibrations, perfect modulation, from frequencies as low as 10 or 20 vibrations a second up to over 6,000 vibrations a second, and probably as high as the audio limit of 15,000 or 20,000. And each electric pulse corresponds in intensity to the sound pulse which gave rise to it. The sequence of electric vibrations is an exact copy of the sequence of the sound vibrations which set it up.

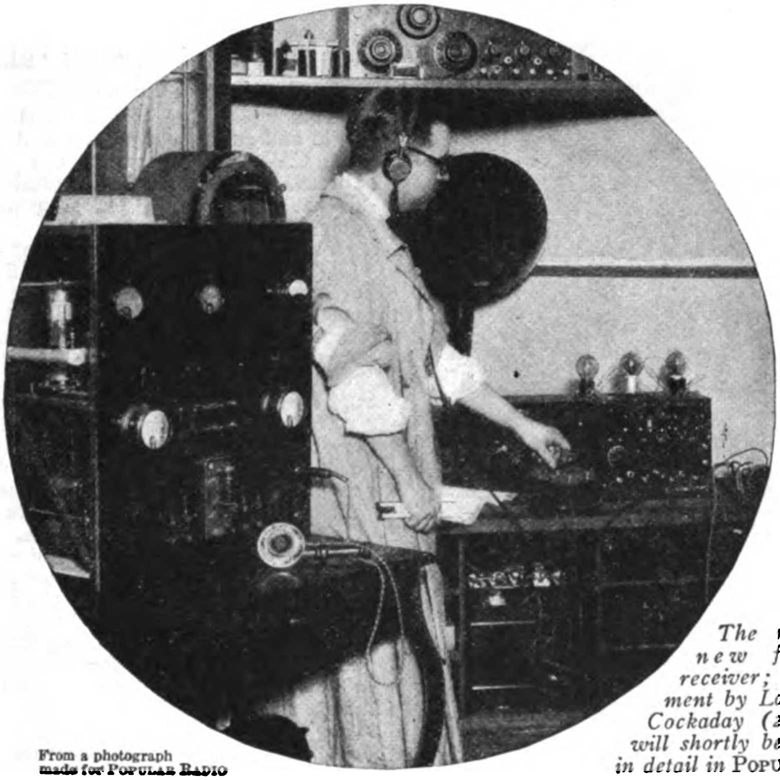
That is, the broadcasting is for the first time perfect. If anything is wrong with the music now it will be in the receiving set or in the musician, not in the transmitter.

The new transmitter was developed for broadcasting, but its usefulness will not stop with this. One imagines that it will be a useful tool in general scientific investigation. There is, for instance, much talk about the means of communication between insects. It seems evident that insects can communicate with each other in some way which we do not understand. There are two suggestions. One, due to Dr. E. P. Felt, State Entomologist of New York, is that insects may be able to communicate by electromagnetic waves, by radio. Another suggestion is that they communicate by sounds too shrill for us to hear. The highest pitch audible to even the most acute human ear is about 20,000 vibrations a second. If insects produce sounds still more shrill than this we could never detect them by our ears alone. We could not hear them.

But Dr. Thomas' ionic detector *could* hear them. We could pick up such sounds, reduce their frequency, and make them audible. Or we could record them electrically.

And this is only one out of innumerable ways in which the new instrument, if it fulfils one-half of its promise, will be assisting the scientist and also, one feels sure, the common man.

¶ *"The radio engineer will be the prophet and the architect of a new social era, the inventor of the first successful system for the education of all the people."*—MAJOR-GENERAL GEORGE O. SQUIER.



From a photograph made for POPULAR RADIO

The remarkable new four-circuit receiver; a development by Laurence M. Cockaday (2XK) that will shortly be described in detail in POPULAR RADIO.

Five Modern Radio Sets

Examples of the Constructive Work That Is Being Done in the Development of the Radio Art by Experienced Amateurs

THE present-day interest in radio is the direct outgrowth of the tinkerings of that handful of American amateurs who first started to investigate the mysteries of "wireless" shortly after Marconi made his startling announcement that he could "telegraph without wires." Since that historic day the ranks of the amateurs have expanded until, a couple of winters ago, the broadcasting wave burst upon the public. Immediately everybody began to take more than a passive interest in radio. To the amateur lies the credit for the rapid development of this new art, both in the fields of experiment and of practical usage.

These five sets were shown at the annual exhibition of the Radio Association of Greater New York as evidence of what the amateur is doing in the construction of his own receiving and transmitting apparatus.

From a photograph made for POPULAR RADIO

THE WIDELY-KNOWN "REINARTZ" TYPE OF RECEIVER

This type single tube receiver is simple to build and consequently has found favor among the C.W. enthusiasts of this country and abroad. The tuning with the receiver is simple; distant signals may be picked up with ease with only one tube.

This set was built by Arthur K. Ransom (2QK). Mr. Ransom completed the set in two evenings' work at home. Immediately upon connecting it to his antenna and ground, he began to receive a long list of amateur and broadcasting DX stations. The set tunes sharply for C.W. and telephone stations, although it is not as selective with spark signals.

The main part of this set is the spiderweb combination inductance. It consists of two coils in one. The plate coil is wound on 9 spokes on a 2½-inch center by weaving in and out between the spokes. Taps are brought out at the 15th, 30th, and 45th turns. At the 45th turn the coil is broken and a lead is brought out.

The second coil is then started and wound in the same direction as the plate coil on the same form, and taps are brought out at the 2nd, 4th, 5th, 6th, 7th, 8th, and 9th turns to the antenna switch; a tap for the ground connection is made at the 10th turn, and taps are also made at the 26th, 33rd, and 40th turns for the grid switch. The coil may be wound on thin cardboard, with the spokes cut out with shears.

Two 23-plate variable condensers may be used. These condensers usually have a capacity of about .0005 mfd.

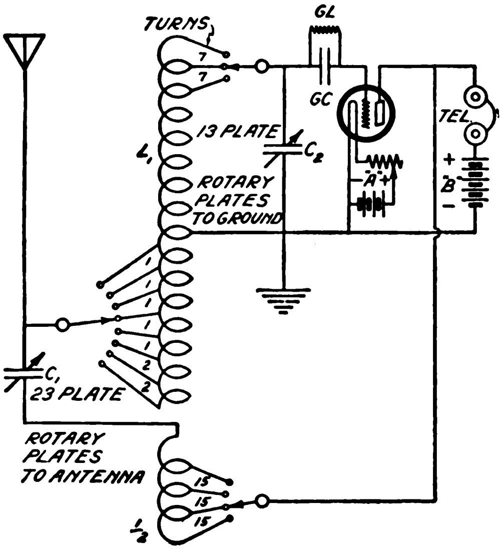
In this set the coil is centrally mounted on a bakelite panel with the antenna taps located directly beneath, and the grid and plate taps above.

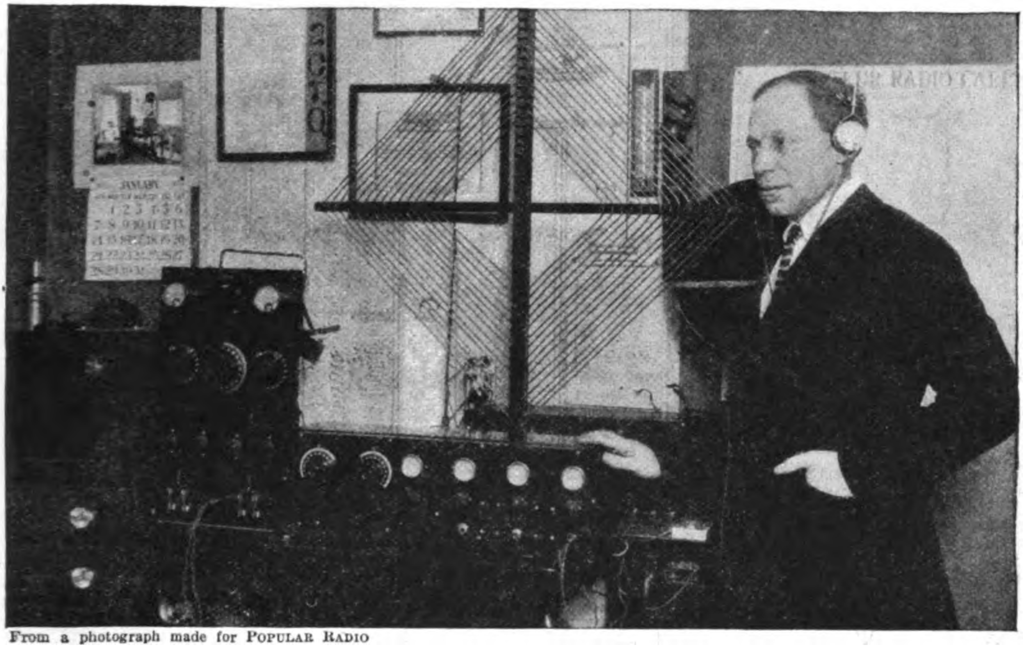
The variable condensers are fastened to the panel on either side of the tuning inductance, and are equipped with knobs and dials for control.

All of the connections between the various instruments and switches are made with square tinned-copper bus-bar wire. The bus-bar connections are run in straight lines in a workmanlike fashion and the set has an appearance that is comparable with the best of commercially manufactured apparatus.

As all of the instruments and connections are mounted directly on the panel, the set may be taken out of the cabinet and inspected at any time without disarrangement of the wiring.

The set will tune from approximately 150 to 400 meters. It may be made to respond to higher wavelengths, however, by using 43-plate condensers (.001 mfd.).





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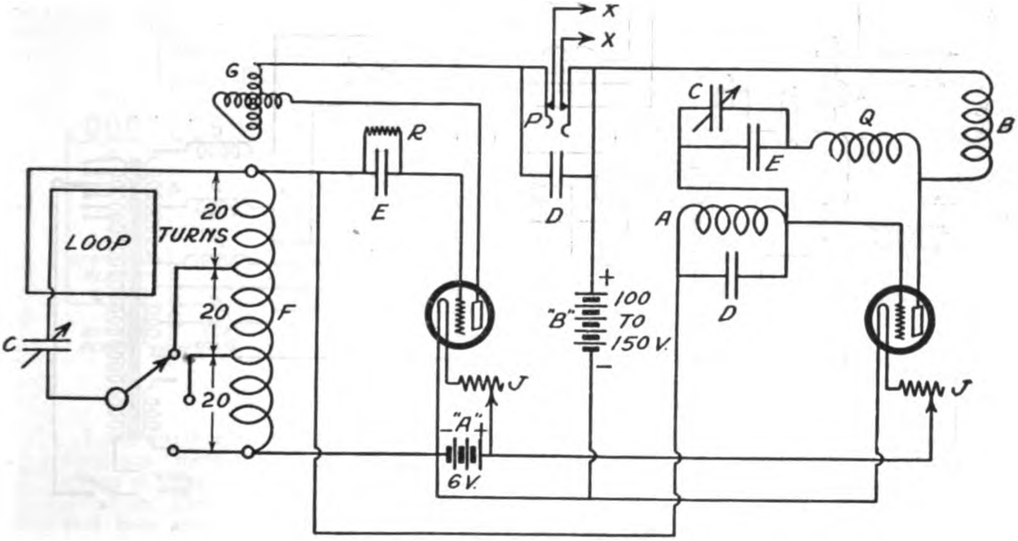


ONE OF THE BEST OF THE SUPER-REGENERATIVE SETS

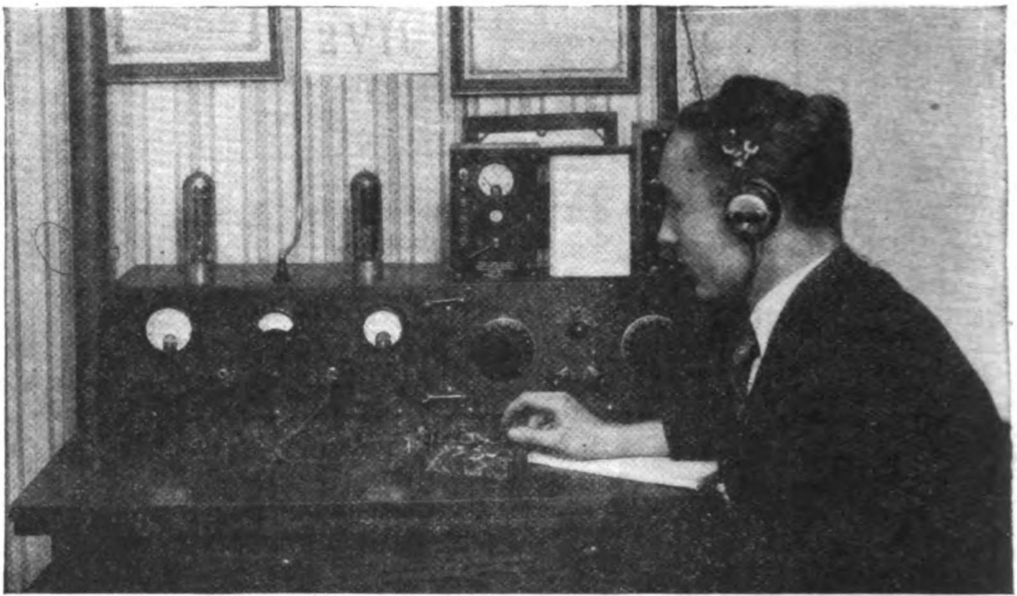
This receiving set was built by Leo Johnson (2CTQ). The parts used are:

A—honeycomb coil, L-1,250
B—honeycomb coil, L-1,500
C—2 variable condensers, .001 mfd.
D—2 mica fixed condensers, .002 mfd.
E—2 mica fixed condensers, .0005 mfd.
F—60 turn coil, of No. 18 S.C.C. wire, wound on a 3½-inch tube and tapped every 20 turns
G—variometer
J—filament rheostats
P—double circuit jack
Q—honeycomb coil, L-200
R—grid leak, 1 megohm

The loop antenna consists of 12 turns of tubular braided antenna wire wound on a loop 2 feet square. Two stages of audio frequency amplification have been added to the circuit at the points XX.

In operating this set it was found that Western Electric 216-A tubes gave superior results to other tubes, both in respect to clarity of reproduction and strength of signals.

The set operates on a loop two feet square which is wound with 12 turns of tubular braided antenna wire.



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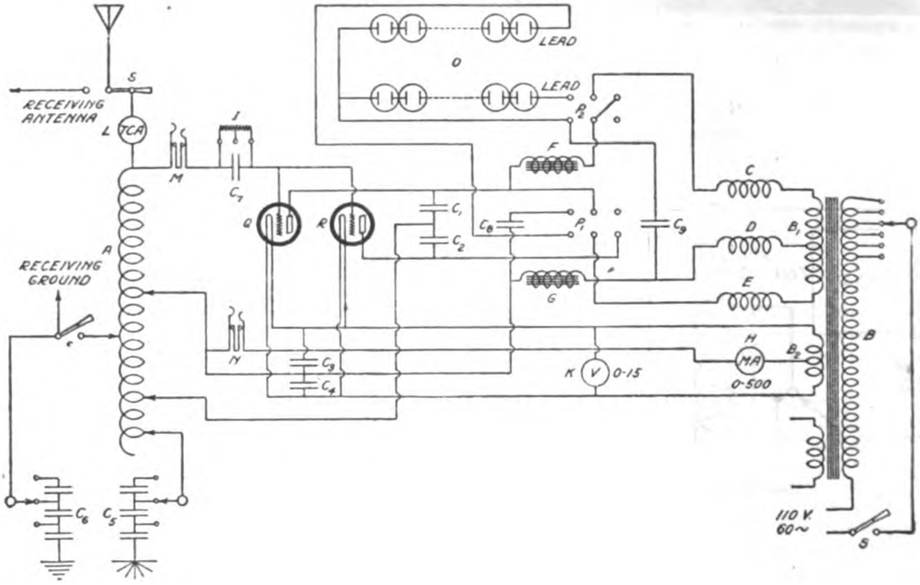
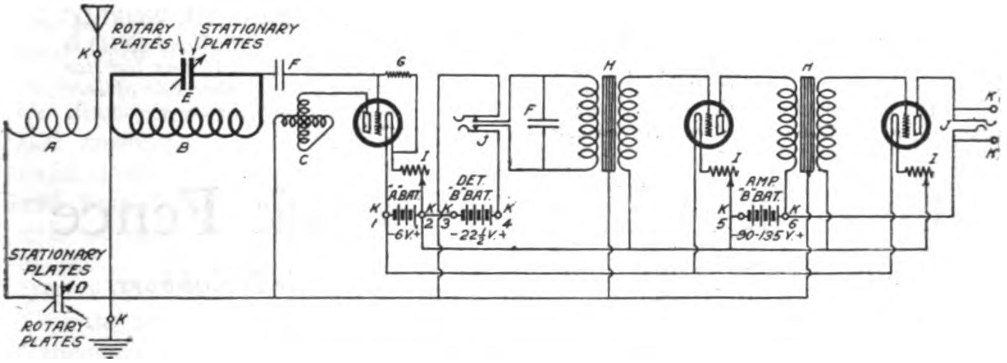


AN EXCEPTIONALLY POWERFUL C.W. TRANSMITTER

This set was built by Paul Haus (2VH). With this type of transmitter, the amateur is enabled to transmit to any district of the United States, to Cuba, and Canada, and across the ocean. Over 300 sets of this type were heard in Europe this winter. The parts used in its construction are as follows:

C1 and C2—high voltage condensers, .002 mfd.
C3 and C4—bypass condensers, .0005 mfd.
C5 and C6—series condensers, .0003-4-5 mfd.
C7—grid condenser, .0005 mfd.
C8 and C9—filter condensers, 1 mfd.
A—tuning inductance, 33 turns of No. 10 wire wound on bakelite strips; diameter of coil, 5 inches.
B—C.W. transformer, 750 watts
C, D and E—honeycomb coils, L-200
B1—high voltage winding, 1,500 volts each side of center tap
B2—filament winding, 12 volts
F and G—iron core chokes, 1½ henries
I—grid leak, 2,500 ohms
K—voltmeter, 0-15 volts A.C.
H—milliameter, 0-500 M.A.
L—thermo-couple ammeter, 0-5 amperes
M—jack for microphone transformer and chopper
N—key jack
O—aluminum-lead chemical rectifier, borax solution, 48 jars
P1 and P2—4 pole double throw switch
Q and R—UV-203 radiotron 50 watt tubes

From a photograph made for POPULAR RADIO



A REAL "DX" RECEIVER

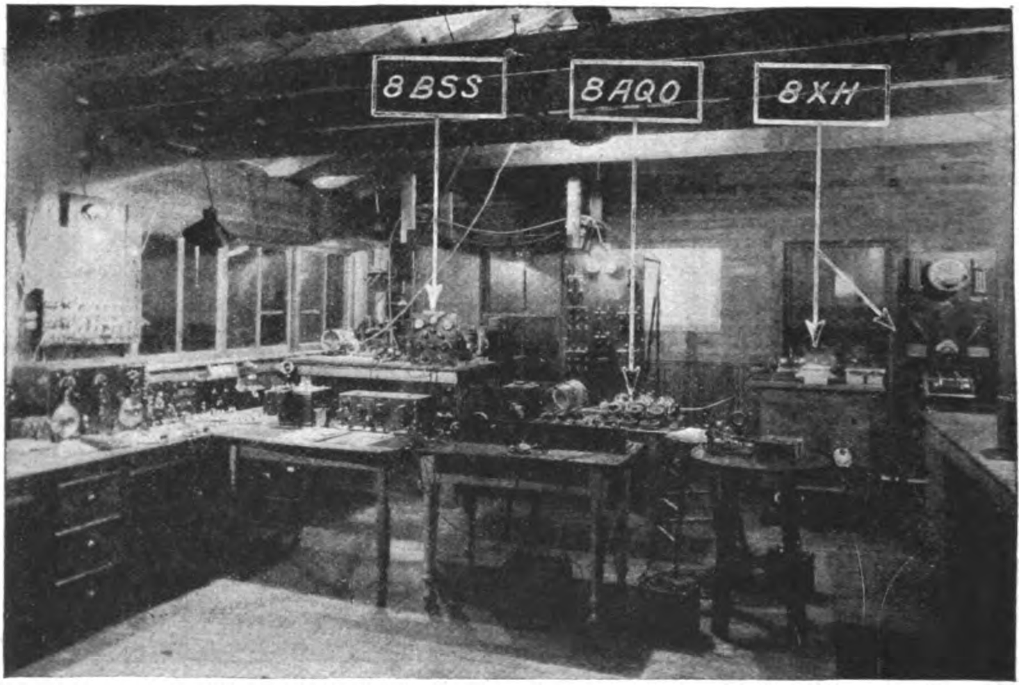
Long-distance receivers that are built by the amateurs themselves are usually wonderful pieces of apparatus, both as to design and construction; they offer convincing indication of just how much the amateur has contributed and is contributing to the art of radio. This receiver, built by J. C. Gorman, has picked up practically all of the broadcasting stations east of Denver, Colorado. It consists of the following parts:

A—primary coil, 25 turns No. 18 S.C.C. wire wound on a 3½-inch tube
B—secondary coil, 60 turns No. 18 wire wound on the same tube with ¼-inch separation between A and B
C—variometer
D—variable condenser, .001 mfd.
E—variable condenser, .0005 mfd.
F—mica grid condenser, .00025 mfd.
G—grid leak, 2 megohms
H—audio frequency amplifying transformer
I—filament rheostats
J—1 two-circuit jack and 1 single-circuit jack
K—binding posts

How many times has the novice had trouble with his set? How many times has he called upon a neighboring amateur for advice and had the more experienced man come over to his house and put his set into operation again? This is one of the pleasures of the regular amateur—to help his less experienced friends in their problems and to instill greater interest in radio among his acquaintances. Why not join a radio club yourself and learn more about radio?

Indeed, one of the most important activities of the amateurs is their radio club work. At these meetings, to which anyone interested in radio is welcomed as a visitor, lectures on new developments and apparatus are given, with educational features for novices and amateurs alike.

Engineers, amateurs and novices alike find much of interest in this association with their fellow radio enthusiasts at radio club meetings.



REPORTED TO BE THE "FINEST AMATEUR STATION IN THE WORLD"
This "three in one" radio station (its three call letters are 8AQO, 8BSS and 8XH) is owned and operated by C. B. Meredith of Cazenovia, New York. It was the star performer of the recent transatlantic tests, and was heard on the other side oftener than any other. It is probably the most complete amateur station in the world; its cost is estimated at about $30,000!

Over the World's Back Fence

The Radio Amateur Begins to Talk to His Neighbors On Other Continents

Just what effect the breaking down of international and intercontinental barriers by the radio amateurs may have upon civilization is a subject for hopeful speculation. But the widespread spanning of oceans on low-powered transmitters is a present and highly significant fact. How the amateurs are doing it is here told by the traffic manager of the American Radio Relay League, which organized the successful transatlantic tests.

BY F. H. SCHNELL

THE down-east farmer who tied a pair of his hip boots to the first telegraph wire and went back to his home in the hills confident that they would be delivered to his son in Baltimore—or was it Washington?—can now attach a pair of his hob-nailed shoes to the antenna of the nearest amateur station with the same hope that they will be sent by radio to his brother, Arthur, in South America.

If there were more of this type of individual who look to every new invention as having infinite possibilities, there would not be so many to marvel at the feat recently accomplished by American amateurs during the third transatlantic tests of the American Radio Relay

League which definitely established international amateur communication by radio.

It should be remembered that these tests were conducted by the radio amateur who knew more about "wireless" ten years ago than the vast majority of fans know today. Even without regeneration or vacuum tubes he was a "stickler" for the technique of the game and lost no opportunity to acquire technical knowledge. The amateur is a type which developed soon after Marconi's achievement became known to the world and he has ever been hopeful of some day catching up and saying:

"I'm with you old man; let's show 'em what we can do with this radio thing anyway."

This opportunity came with the third annual American Radio Relay League transatlantic tests. When 6KA, operated by F. E. Nikirk, of Los Angeles, California, loped across the country in its peculiar western fashion and started to tickle the ether around Paris about 15,000 amateurs in the United States, Canada, Porto Rico and the Hawaiian Islands took their receivers off, and with a grin spread across their faces, announced:

"Did we? I'll say we did!"

That the tests were a success beyond the amateurs' most hopeful dreams became evident long before the final reports had been prepared by the operating department. The first successful attempt of the British and French stations to transmit their signals to this country also gave evidence of the ability of American amateurs in reception, so that the results were highly satisfactory for all concerned. Although only three foreign stations 2FZ (the Wireless Society of Manchester); 5WS (the Radio Society of Great Britain) and 8AB (operated by Leon Deloy at Nice, France), "got across," it should be remembered that the total number of stations transmitting from these two countries was thirty-four, while 324 qualified for the final tests for transmission from this side of the Atlantic.

The radio amateurs of this country were literally "keeled over" by the report that 316 of their stations were heard by European amateurs, and straightway began to make ready for the final test of achievement; instantaneous two-way transmission of complete messages by the

De Georges

ONE OF THE FIRST STATIONS
TO BE HEARD OVERSEAS

Harry Collins at work in his radio station 2AJW, at Babylon, Long Island. His small transmitter, with a few 5-watt tubes, he literally "threw together" in time for the transatlantic tests.

most efficient transmitting and receiving sets in both continents. This point achieved, and with reports coming in from remote countries and operators on board ships off the coast of Australia and Japan, American amateurs will be looking forward expectantly to that day in the not too distant future when their messages will encircle the globe.

The showing during the preliminary tests when British amateurs logged 23 American amateur stations was almost equal to the finals last year when Paul F. Godley was sent to Scotland by the League to copy the signals of the American transmitting stations. The number of stations heard during the first week of the tests this year was almost five times the number of those heard during the entire tests of 1921. Never before had any American stations been heard in Switzerland. Signals from two Canadian stations were reported this year as compared with one last year. An amateur station in Porto Rico, operated by L. Rexach, was reported. He operated only five minutes on the first night—before his tubes blew out.

The ability of American amateurs to transmit has been demonstrated as never before, although indications are that British and French amateurs outclass them when it comes to long-distance reception.

With amateurs of all countries alive to the possibilities of long-distance communication with amateurs of other countries that have been indicated by the enterprise of American, Canadian and European operators during the tests, amateur radio may be expected to take a decided jump forward, provided the other governments will grant the necessary privilege of transmitting to those who are now restricted. American amateurs have shown the way; it only remains for others to develop along the same lines.

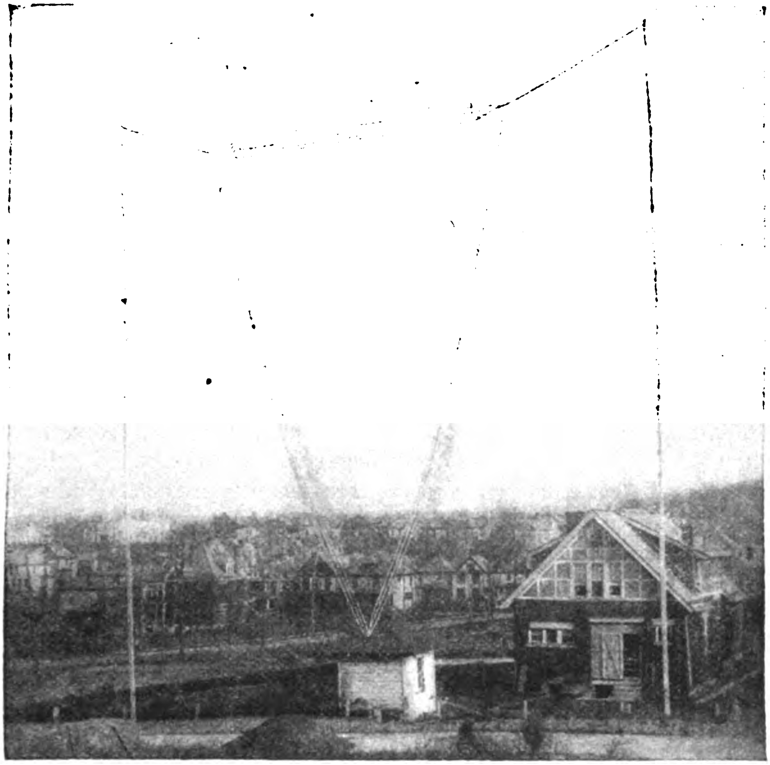
It is almost beyond the stretch of the imagination to conceive just what may come with international amateur radio communication, the ability of a private citizen of one country to talk with a private citizen in another country with the same ease that one radio amateur now communicates with another a few hundred miles distant.

It is rather difficult for the average man, talking with his neighbor over the back fence, to imagine that it will be only a matter of time before he can talk as easily with friends in Europe.

The American amateur by these tests has done more than bring the two continents closer together; he has paved the way for greater international relations between citizens of all countries. It will be some months before results of these tests can be definitely determined; reports already coming in seem to indicate that records yet undreamed of have been made by our transmitting stations that took active part in the tests.

The amateur has kept abreast with the progress in radio to a surprising extent. He does not lack imagination as to the possibilities of his home-made apparatus. If a census were taken he would not be found the least active among those who helped to make radio what it is today. He has delved into all branches of the art. While his apparatus may be apparently a collection of stray parts, it will be found usually that his equipment is equal in efficiency to the more costly ready-made apparatus.

The radio amateurs of this country will soon be able, sitting in their own private homes, to communicate constantly with the amateurs of European countries in their private homes, and then the American boy will be even more active in the transmission and reception of messages than now, and his parents, who may not be so well initiated into the mysteries of radio, are going to be astonished by the achievements of his inexpensively made amateur radio. Even at this late date when it is fast going out of fashion to be surprised at anything, the individual who uses the telephone and telegraph as a matter of daily routine is going to register at least a hint of



A REMARKABLY EFFICIENT AMATEUR ANTENNA

Radio station 8SP at Fairmont, West Virginia (owned and operated by A. Kisner) is noted for its reliable long-distance work. One of its outstanding features is its novel cage antenna with two smaller cage lead-ins, one at either end.

astonishment at the thought of communicating as easily with individuals across the water.

Of course the amateurs will hold to their friendly messages without any thought of infringing on the rights of the commercial companies in message handling. The amateur aim is of experimental nature rather than from the standpoint of financial return. Amateur operation is for the love of the game and the knowledge acquired as a result of experiments by which the art may be further advanced. Interest in short-wave communication is growing and an effort is being made to locate interested amateurs in the Southern Hemisphere, as it is believed that it is possible to connect American and the English-speaking people in South Africa and South America.

This test was regarded by Hiram Percy Maxim, president of the League, as one of the most impressive we have had happen during the present generation. Mr. Maxim says, "I feel as I felt when Peary announced that he had stood at the North Pole, where with a single step he moved from the Eastern to the Western Hemisphere."

A striking similarity to this statement can be recited from my own experience; it brings to mind a conversation I had with Leon Deloy, the only French amateur to transmit successfully to amateurs in this country in the transatlantic tests. During the war, when I was stationed at the Transatlantic Control Office in Washington, he was in the French Signal Corps and also stationed in Washington. I discussed with him the future of amateur communication and mentioned casually that we amateurs would be one day chatting with each other *via* transatlantic amateur radio. He said that he thought it would be possible and that he hoped the French Government would permit amateur transmission, which up until this time it had not. All this has happened in the short space of three years; in a letter received just a few days ago from Deloy, he says:

"Well, OM, this is a great day for me and I know you will be glad too, as the first half of your prediction of three years ago has come true! Now for the other half! I must get through to you."

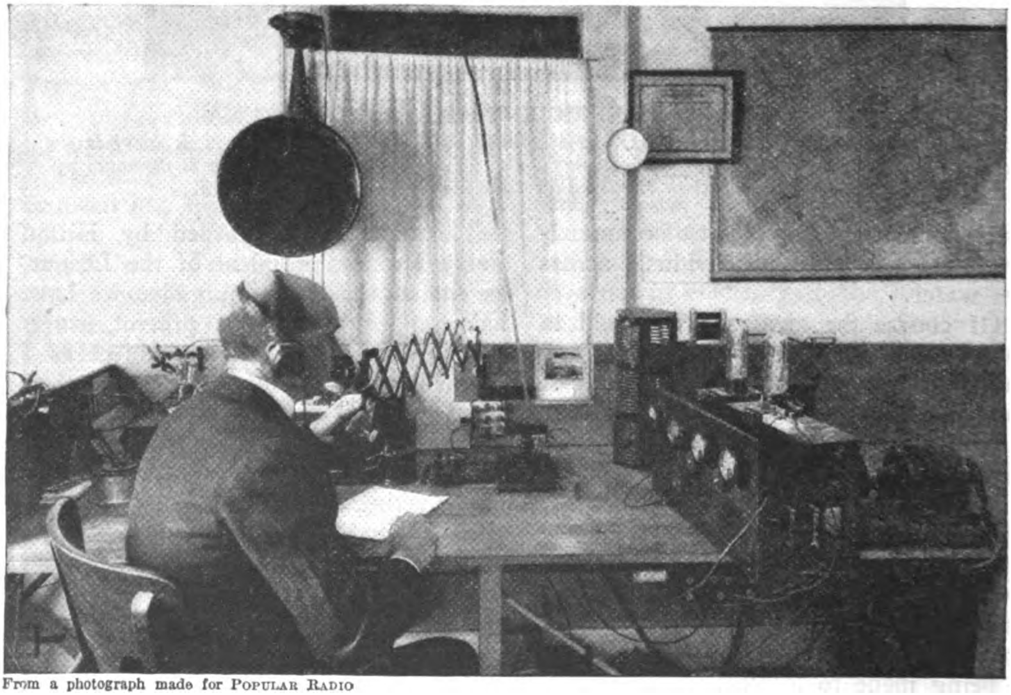
Deloy's station did get through and was copied for an hour on one night of the tests by C. A. Service, assistant secretary of the League, who also was with us at Washington.

But what is even more surprising to me is that not only did well-equipped, powerful amateur stations that qualified in the preliminary tests "get across," but also a large number of crude home-made sets, some of them with no more power than it would take to heat the filament on a 50-watt electric lamp. Probably a vast majority of our most successful stations during the transatlantic tests represented a collection of home-made parts, carefully tuned for greatest efficiency.

During the preliminary tests, Mr. Maxim often referred to his own set (1AW) as a "mere toy," saying to me:

"Schnell, we need something with a bigger bite, this is only a little nibble."

He meant particularly the little transmitter consisting of four 5-watt tubes with which we were able to squeeze about two amperes into the "toy antenna" consisting of a four-wire cage with wires spaced about one and one-half inches



From a photograph made for POPULAR RADIO

A YANKEE AMATEUR WHOSE SIGNALS ARE HEARD BY HALF THE GLOBE

Here is J. O. Smith, at the helm of his record-breaking station at Valley Stream, Long Island. "J. O." has tried out about every kind of circuit and all of the various types of transmitting tubes. But it does not seem to make much difference what he uses he is always breaking records.

From a photograph made for POPULAR RADIO

HE TALKED WITH EUROPEAN AMATEURS
FIVE CONSECUTIVE NIGHTS

Floyd L. Vanderpool and his exceptionally complete radio station 1BEP, at Litchfield, Connecticut. The powerful C.W. transmitter at the left was heard on five evenings in succession by both English and French amateurs.

apart. Practically speaking it was a large single wire antenna and nothing more, 80 feet high at one end and about twelve feet at the near end, and when I reported to him that 1AW had been heard by amateurs in France, he exclaimed:

"My ideas and training on radio will need smoothing out and some explanation for this low-power business of transatlantic communication will be forthcoming."

Station 1AW was one of the last to give up the old spark, but with the coming of broadcast listening and for fear of unjust complaints and criticism because of spark interference, Mr. Maxim changed over to C.W. in time to avoid any such happenings, and the good showing was the cause of his remark that the spark at 1AW will be heard no more.

There is no more enthusiastic amateur than Herbert Hoover, Jr., whose station (3ZH) at Washington, D. C., was heard by amateurs in Switzerland on December 21st, the last day of sending by American stations. The first thing which he did on his return from college for the holidays was to rig up a special radio set at the Bureau of Standards in order to take part in the transatlantic tests. In a letter to me he thus described his station, which was successful in "getting over."

"It consisted of four 'Mullard' tubes, with an input of about 150 watts each. As they got warm over 1,000 watts input, the station would be rated at 500- or 600-watts output. High-voltage dry batteries were used for the plate supply and at 1,500 volts they put six amperes into the antenna. I erected both the antenna and set just for these tests through the courtesy of Dr. Stratton, who will be overjoyed at the good news.

"The antenna is a 50-foot cage, 2 feet in diameter, strung from the Navy mast to the Electrical building. It is about 125 feet high and the lead-in is partly cage (6 inches) and partly ribbon. As the high-voltage battery leads extended all the way through the building, they in themselves, acted as a very good ground. When using the reversed feedback circuit, I tuned the counterpoise (a semi-circular pan of 30-foot radius) to the rest of the set with a separate inductance, and used no other ground connection at all.

"I tested during the 'free-for-all' that evening and afterward worked 9BHX, but DX work was very hard, for the wave is 240 (I can't get lower on account of battery leads) and very sharp. The receiver is a D.S. amplifier with an external heterodyne, and it has a 'CR' skinned a mile! NOF is going, too."

It is not without the bounds of possibility to pre-suppose that an amateur "relay around the world" is not far off. Were there radio amateurs in Australia, Japan, China and the Philippines, this would be but a matter of making the necessary arrangements and conducting the preliminary tests. Preliminary tests are necessary because the weak points are thereby located and readily reinforced. As an example of what is possible, a message may be started from London, England, picked up on the Atlantic Coast of the United States, relayed to the Pacific Coast, thence to the Hawaiian Islands, to Japan, Australia and the Philippines, thence perhaps through one or two European countries, back into London.

With our successful "radio" acquisition of the Hawaiian Islands and Porto Rico during the last year, there is every reason to believe that we may connect up with countries in the Southern Hemisphere, especially South America and South Africa.

Who would dare to be bold enough to say?

From a photograph made for POPULAR RADIO

A YEAR-OLD STATION THAT HAS BEEN LOGGED
IN SIX COUNTRIES

The amateur radio station 3BLF at Richmond, Virginia, is owned and operated by the youthful C. R. Hofmann and W. R. Deavers. Its C.W. signals have been logged all over the United States as well as in Canada, Hawaii, Cuba, France and England.

WHAT READERS ASK

This department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask The Technical Editor.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our *subscription list*. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.

Question: I have read the article on the DX regenerative receiver in the January issue and would like to know if this circuit could be simplified so that only one or two controls need be used for tuning. I wish to use one tube only (for detector). Will you kindly furnish me such a diagram?

A. L. Williams

Answer: A simplified modification of the DX circuit is shown in Figure 1. Coils A and B are wound on a 3½-inch tube with a separa-

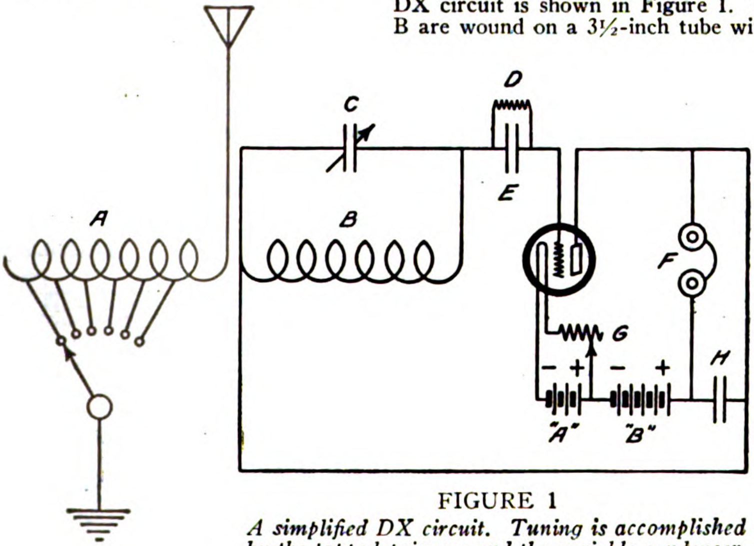
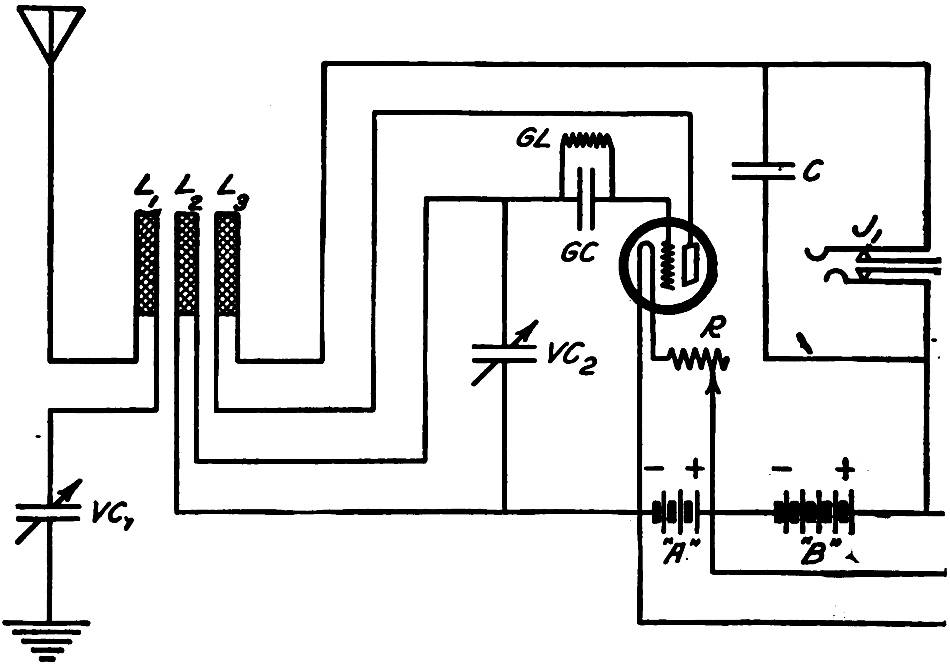


FIGURE 1

A simplified DX circuit. Tuning is accomplished by the tapped primary and the variable condenser.



tion between them of ½ inch. The primary coil A consists of 30 turns of No. 18 S.C.C. copper wire tapped every five turns. The secondary coil B consists of 65 turns of the same wire. The condenser C is a variable .0005 mfd. The grid leak D is 1 or 2 megohms; the grid condenser E is of .00025 mfd. capacity; the rheostat G is approximately 5 ohms; the fixed condenser H is a telephone condenser, .001 mfd.

The antenna tuning is accomplished by means of the taps on coil A. Secondary tuning is done with condenser C. Regeneration is controlled with rheostat G, which should have a vernier attachment. This circuit will be found exceptionally selective and easy to tune.

* * *

Question: Will you kindly give me a hook-up showing how to add two stages of audio frequency amplification to the honeycomb circuit shown in Figure 1 on page 59 of the May issue of Popular Radio?

Wilfred Burgess

Answer: The circuit is shown in Figure 2. The two jacks J1 and J2 are double circuit jacks, and J3 is a single circuit jack. The transformers AFT are audio frequency transformers. This circuit will enable you to use a loudspeaker.

* * *

Question: In one of your diagrams in answer to a question, you specify Radiotron UV-200 tubes for detection and UV-201 tubes for amplification. Out on this coast we find the Cunningham C-300 and C-301 sold more in the radio stores. Is there any preference between these two types? As far as I can see they are constructed exactly alike.

Francis Stern

Answer: Both of these two makes are good. The UV-200 and C-300 are soft tubes and are used as detectors, and the C-301 and UV-201 are hard tubes and are used as either detectors or amplifiers.

* * *

Question: What kind of wire is most suitable for a receiving antenna?

Harold Jenkins

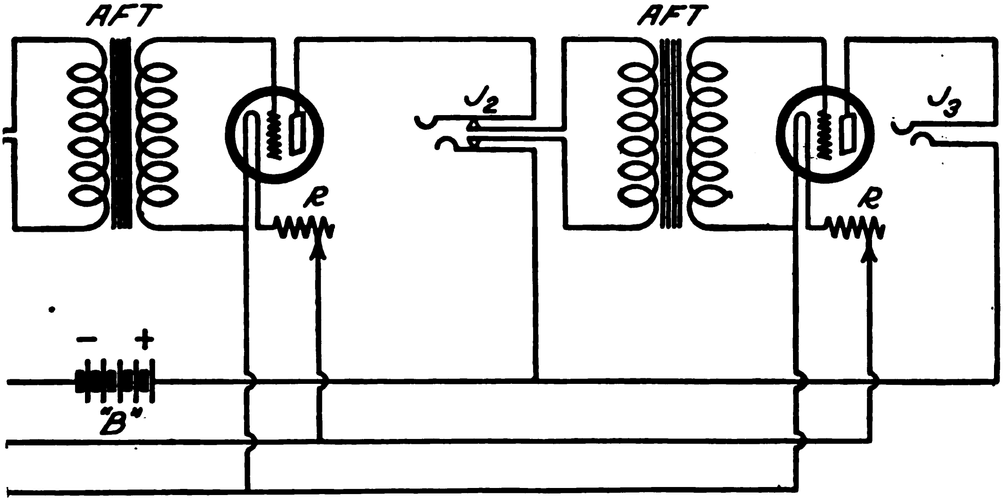
Answer: Seven-strand copper wire is the wire that is most generally used for the antenna. It is usually No. 12 or 14 and is kept in stock by most radio dealers.

* * *

Question: Please give me a diagram for a small radiophone transmitter that uses a Radiotron amplifier tube. I want the simplest hook-up that works. This will be my first transmitting set and I want to get familiar with a small one to start with. I want to work the set on

FIGURE 2

A three-coil honeycomb set with two stages of amplification that gives loud and clear signals on a loudspeaker.



a bank of "B" batteries. If this is possible please let me know what voltage batteries to use on the plate.

HOWARD V. BROOKS

ANSWER: We have drawn the circuit for you in Figure 3. The two coils P and S have 60 turns of wire wound on each of them. Coil P is wound on a 4-inch tube and coil S is wound on a tube slightly smaller so that it may be slipped inside coil P. The variable condenser VC should be of .001 mfd. capacity. It is advisable to tap the two coils at every other turn and make adjustable connection to them, for tuning, by means of clips. The variable condenser will be valuable in getting the set to oscillate properly. A voltage of approximately 100 to 125 volts should be used on the plate of the tube, but voltage less than this may be used, with, of course, a corresponding decrease in distance range. The microphone transmitter is connected to a loop consisting of a single turn of insulated wire wrapped around coil P. This, by absorption, causes the output of the set to be modulated at voice frequencies, when the microphone is spoken into. A transmitting license is required.

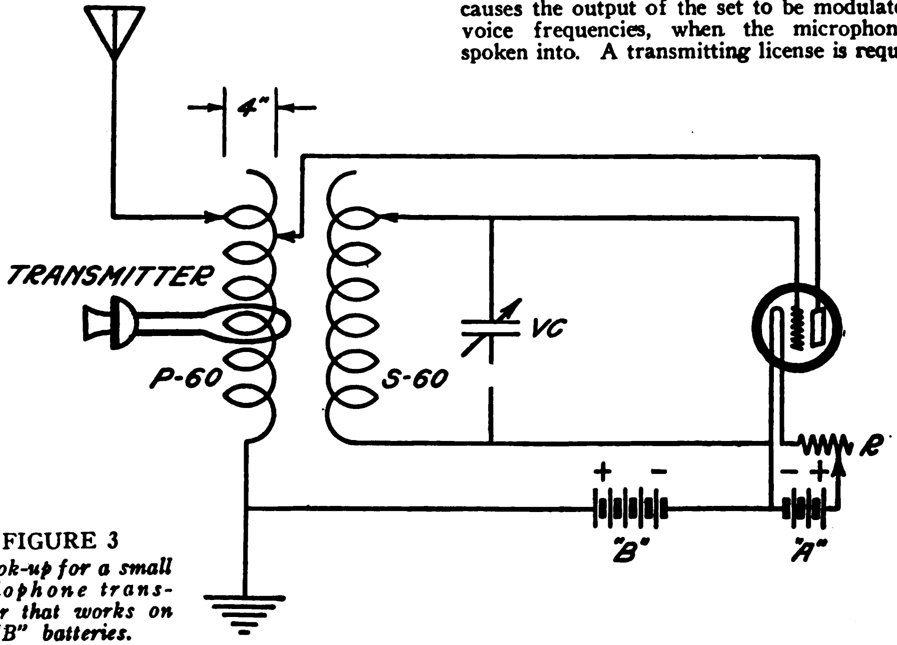


FIGURE 3
A hook-up for a small radiophone transmitter that works on "B" batteries.

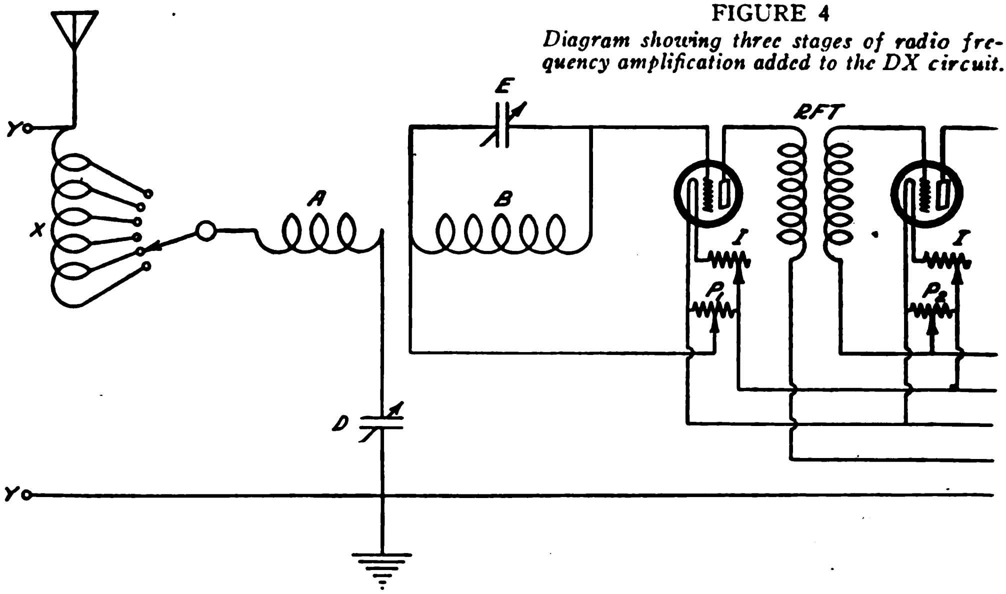


FIGURE 4

Diagram showing three stages of radio frequency amplification added to the DX circuit.

QUESTION: I have built the DX regenerative receiver described in your January number.

I have not been able to hear the other coast as yet, but I believe that if I added a few stages of radio frequency amplification to it, I could. Sharpness of tuning is its best quality. Would it be possible to add radio frequency and still retain the fine tuning qualities? If so, please send me the hook-up.

R. K. BENTMAN

ANSWER: The circuit diagram in Figure 4 shows how to add three stages of radio frequency amplification to the DX receiver. The variometer has been eliminated and a loading coil has been added. The two binding posts YY are for connection to a loop antenna if used. The potentiometers P1, and P2 are to control the grid circuits of the radio frequency tubes; they may also be used to control oscillation so that the circuit will receive C.W. The three radio frequency amplifying transformers, RFT, must be of a reliable make and have a wavelength range that will include that of broadcasting, as your query indicates that is the phase of receiving that interests you most. The other designations on the diagram refer to the same parts they did in the article in the January issue of POPULAR RADIO.

* * *

QUESTION: What is the normal distance range of the different types of radio receivers? I would like to know this roughly, so that I will be able to pick out a type of set that will suit my purpose.

ARTHUR C. STRANG

ANSWER: If you will refer to the article on page 24 in the January issue of POPULAR RADIO you will find data that will answer your inquiry in much greater detail than we could do in this space. The article contains data on this subject which should prove invaluable to the novice in selecting his set. There are two charts that will show you, at a glance, the type of receiver that will be best for you to use.

* * *

QUESTION: How many turns of wire should be wound on the rotor and stator of a variometer for use in the plate circuit of a regenerative receiver? I want to make one myself and am going to copy the design of one of the wooden variometers now on the market.

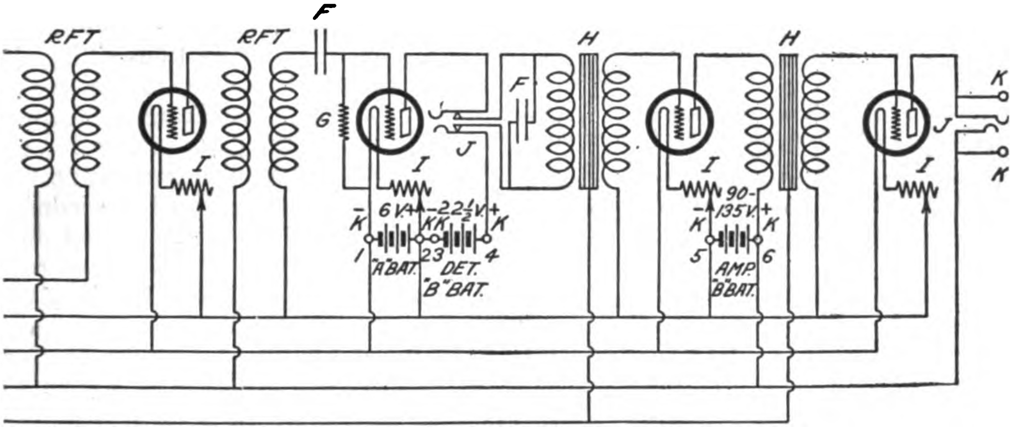
ROBT. M. ASHTON

ANSWER: If you make the variometer stator and rotor forms of approximately the same size as the most commonly used variometers you may use 40 turns on the stator and 50 turns on the rotor with good results. Use as little shellac as possible on the windings.

* * *

QUESTION—Can a variometer be used as a variocoupler?

L. E. T.



Answer: Yes. If the stator winding is detached from the rotor winding it can be used as the primary coil, with a variable condenser in series with the antenna circuit for tuning. The rotor winding may then be used as the secondary, with another variable condenser connected in shunt to it for tuning the secondary circuit. Or, in the single circuit regenerative hook-up, the rotor may be used as a tickler, as shown in Figure 3, page 223 of the July issue of Popular Radio.

* * *

Question: Will you kindly give me a circuit for a C.W. transmitter using one 5-watt tube, for telegraphy? I should like a circuit that will be simple to construct and yet efficient. I have heard a great deal of the "British aircraft circuit" and would like to use it if you think it would serve my purpose.

A. R. Woodworth

Answer: The circuit shown in Figure 5 will be suitable for your use, and it is easy to operate. .The plate coil L1 consists of 40 turns of No. 12 D.C.C. copper wire wound on a tube four inches in diameter. The grid coil L2 should be wound on a tube which fits inside the plate coil L1, and should consist of about 10 turns of the same sized wire. This coil is shunted by a variable condenser, but if the coil is tapped the condenser may be eliminated. The condenser C which is connected across the high voltage terminals of the transformer may be between .001 and .005 mfd. capacity. The same transformer is used for lighting the filament. The hotwire ammeter is used to measure the antenna current. A milliameter, 0 to 100 milliampere scale, may be inserted in the plate circuit to measure the plate current if desired.

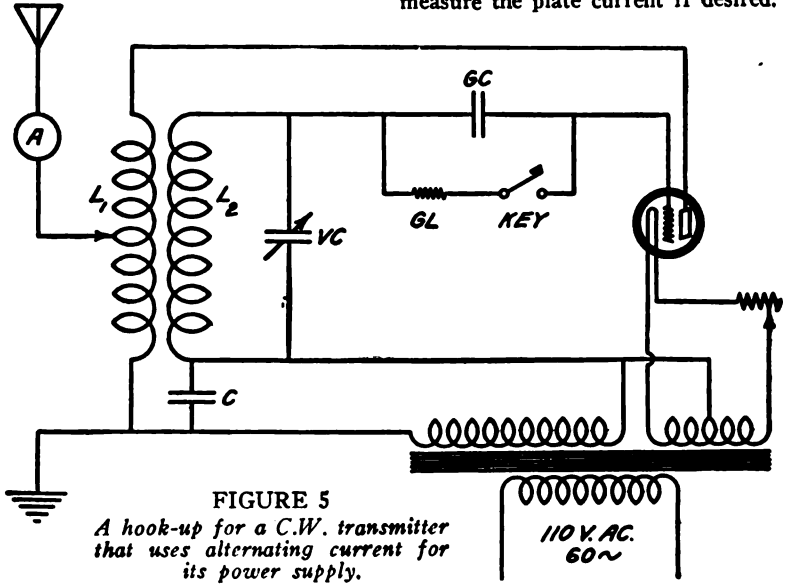


FIGURE 5
A hook-up for a C.W. transmitter that uses alternating current for its power supply.

QUESTION: Are paper grid condensers as good as mica grid condensers?

DONALD DIETZ

ANSWER: Paper condensers are not as reliable as the mica dielectric type because the capacity of the paper type is liable to vary with temperature and with pressure. Try this: use a paper grid condenser and tune in a signal. Then pinch the condenser between the fingers and the signals will tune in and out.

* * *

QUESTION: What is the greatest number of stages of audio frequency amplification that can be used with clear efficient reception?

THOMAS McCOOMBS

ANSWER: With two stages of audio frequency working efficiently, getting the maximum out of the vacuum tubes by means of the correct circuit, the correct transformers (transformers with the proper input and output impedances) and the best tubes, the signal strength will be as loud as with numerous stages, using instruments and tubes that *do not* match up properly. It is our opinion that two stages of audio frequency amplification constitute the greatest number of stages that should be used. There are many instances where three stages have been used with good results, but in most of these cases the amplification obtained in each stage has not been at a maximum. When more than two stages are employed with maximum amplification in each stage, there are usually many extraneous noises present that tend to interfere with and distort the received signals. Even with only two stages of amplification attached to a regenerative receiver the distortion, caused by regeneration, is often noticeable.

QUESTION: An amateur friend of mine recently interested me in transmitting (I was a broadcast listener up to this time); he made me a transmitting inductance and told me all the parts to buy for an A.C.C.W. vacuum tube transmitter. I am sending you a sketch of the inductance. My friend told me at the time that one coil was for the antenna circuit, one for the grid circuit and one for the plate circuit, and that the last two coils were to be shunted by variable condensers for tuning. He also made me a diagram to connect up the set, which I have unfortunately mislaid. I cannot get in touch with him and am impatient to get it hooked up and working so that I will be a *regular* amateur. Will you kindly help me out with a circuit that will show how to connect the power transformer for one Cunningham 5-watt transmitting tube? I have already learned the code and obtained a license.

ROBERT V. ASHCROFT

ANSWER: You will find the circuit you need in Figure 6. You will need another condenser C which should be about .002 mfd. capacity, and a grid leak 8,000 to 10,000 ohms. The key is inserted in series with the grid leak, for telegraphy. You will also need an antenna-current meter which should have a full scale deflection up to about 2 amperes.

You will get better results with this circuit if you use a counterpoise instead of a ground.

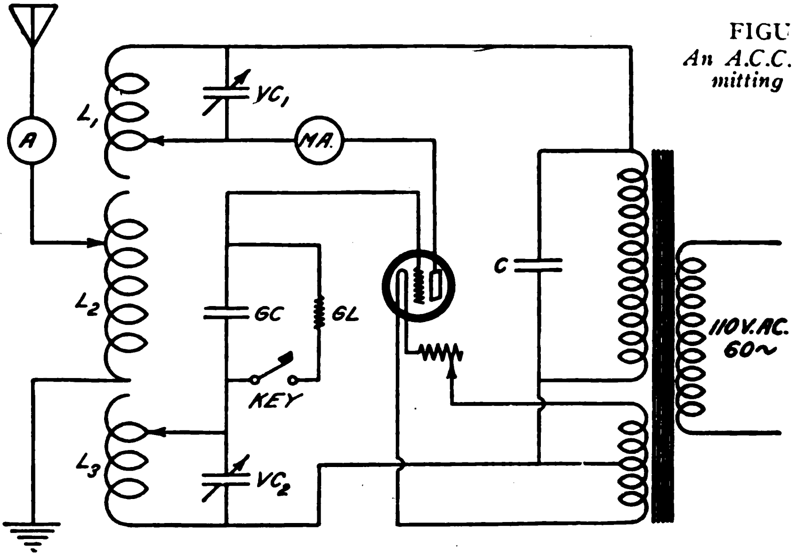


FIGURE 6

An A.C.C.W. transmitting circuit.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Will the Senate Pass the New Radio Bill?

OF such importance to the radio fans as well as to the radio industry is the fate of the White Bill in the Senate that POPULAR RADIO has requested a last-minute report on it from one who had been perhaps more intimately identified with it than any amateur in the country. Here it is:

Just as this is written the word comes that the Senate has taken action which would tend to sidetrack radio legislation. In an effort to hasten through impending bills of major importance, the Administration has used every argument which would affect their passage. If the Senate does not take action on the radio bill during this session it will probably be a year before action can be taken at all. Those who have worked so diligently in an effort to put through this legislation during the present session view the possibilities of the immediate future with concern.

There have been many attempts made to have our Congress pass radio legislation since the first radio laws were placed on the statute books back in 1912. Most of these efforts have been made as the result of the desires of a particular class or of a particular organization. Always—and mainly on this account—the attempts have given rise to controversies as they have been brought before the Congressional committees for hearings. Notwithstanding the many attempts, no changes in the laws of 1912 have yet been effected.

Unlike past attempts at revision of radio legislation, the present bill (which is known in Congress as the White Bill) came about as a result of a conference of radio men called by the Secretary of Commerce, Herbert Hoover. The interests of the Army, the Navy, the commercial companies, the amateurs and the general public were all well taken care of and were fully represented at the conference. Secretary Hoover appointed a committee of representative radio men whose recommendations were drafted into the bill.

The hearing on the White Bill before the Committee of Merchant Marine and Fisheries was a short one. No objections of importance were raised to the bill as framed; most of the comment had to do merely with the clarification of certain phrases.

For example: the amateurs wanted to be recognized by law in such way that their future would be secure, while certain commercial companies wanted the wording of the bill to be changed so as to differentiate between lawful and unlawful monopolies.

From all appearances, it was upon this point of differentiation between lawful and unlawful monopolies of radio that the fate of the bill in the Senate hung. One of the Senators from Texas wished to so amend the bill as to prevent the creation of a radio monopoly. As soon as it appeared that considerable discussion and delay was inevitable, the whole measure was sidetracked.

The efforts of Secretary of Commerce Hoover have been so productive of results in the past, and his abilities to show the great need for this legislation have proven so potent, that in all quarters there is hope that even yet some action may be taken, but the indications are that action during this session is unlikely.

Legislation that will modernize present radio laws is an absolute necessity. Everyone who is getting the least of enjoyment out of radio broadcasting and the operation of amateur receivers and transmitters is vitally interested in securing legislation at the earliest possible moment. Possibly an extra session of the Congress will be called; there is some likelihood of it. On the chance that a session will be called, it is recommended that those who have the welfare of radio at heart continue to forward communications to their Senators and Representatives urging action.

Send this message to your Congressman and to your Senator at Washington:

"I favor the radio bill, H. R. 11964."

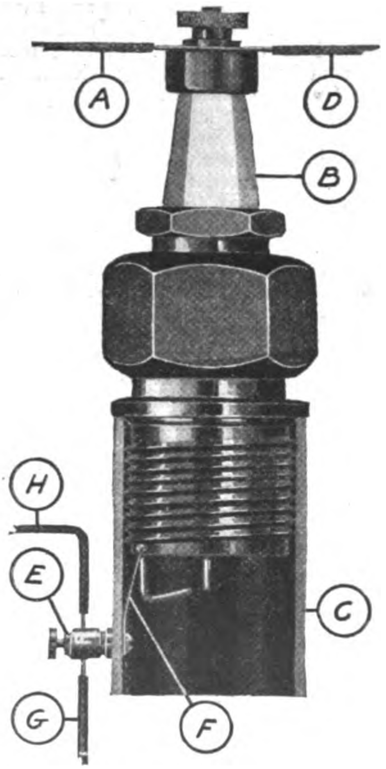
And sign it with your name and address.

PAUL GODLEY

Radio Holds the Hotel Bread Line

ENTERPRISING hotel managers have been quick to seize upon radio as a means for bringing in good entertainment for their guests at a low cost. Last summer the broadcast concerts of the great New York Philharmonic Orchestra (initiated by this magazine) were received in tiny hostelries that could not even support a pianist! How the same idea is being adapted on western ranches is told in this letter from Los Angeles:

> The Fontana Farms Company has an 18,000-acre ranch six miles west of San Bernardino. Recently the ranch opened up for sale 2,000 acres of young vineyards, and every Sunday brought to the place carloads of possible buyers. As many as a hundred guests have registered at the ranch dining-room for Sunday dinner. But as the seating capacity was only fifty, the manager was confronted with the problem of entertaining guests while they waited their turn at the table.
>
> Radio solved his problem. He purchased one of the largest radio sets he could find in all Southern California, and installed it with loudspeaker in the reception room. This outfit, which is of the short wave regenerator type, is capable of being tuned from 200 to 600 meters and easily picks up messages from as far away as Denver. The idea is being adopted by other hotel owners.
>
> CLARENCE M. LINDSAY



HOW THE TRANSFORMATION IS MADE

Here are shown the details of the converted spark plug. A is the aerial wire; B is the insulating column of the plug; C is the fibre tube; D is the aerial connection to the set; E is the extra binding post; F is the connecting wire; G is the ground wire and H is the ground connection to the set.

* * *

How to Convert a Spark Plug into a Lightning Arrester

HAVE you a little lightning arrester in your home? If not, you can make one yourself out of a spark plug and save a tidy little sum of money into the bargain. A correspondent from Kansas City tells in this letter how to do it:

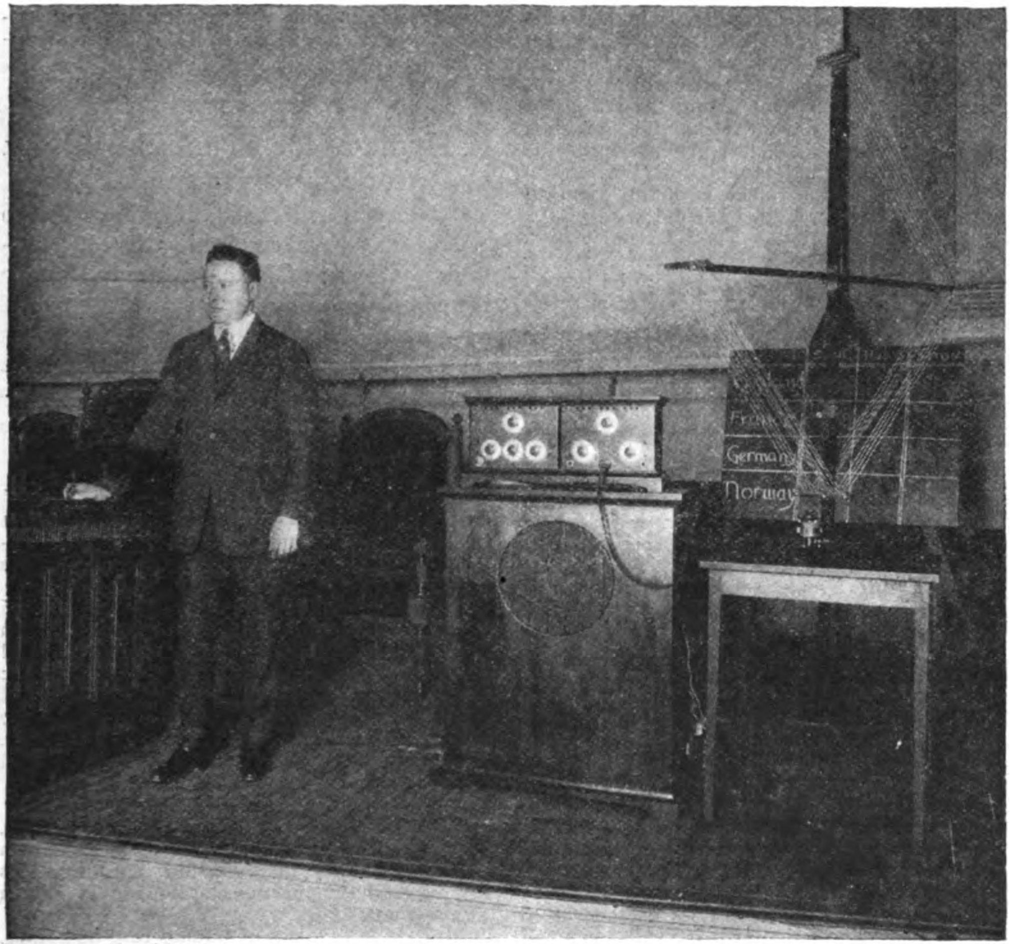
> An efficient lightning arrester for outdoor use can be made from a spark plug. The plug is used complete and must be in good condition. A wire is soldered to the metal body of the plug, then a 2-inch length of fibre tubing is pushed up over the threads. Near the bottom of this fibre tube, a binding post is mounted, and the other end of the wire soldered to the metal body is connected to this binding post, as is shown in the diagram on this page. If this arrester is used in an upright position, the bottom need not be sealed. In use, the aerial lead-in is connected to the plug terminal and the ground connection is made at the binding post. MARION J. ESTES

* * *

A Startling Announcement by Radio

FROM "the great open spaces, where men are men" comes this unexpected little item; William P. Bear assures us that he heard the announcer of a broadcasting station actually make this naive statement by radio:

> "This is Station XXX. Mr. Jones will now sing *Put Me in My Little Bed* accompanied by Miss Smith."



Radio Corporation of America

COMMUNICATING ACROSS THE ATLANTIC WITH THREE COUNTRIES IN 11 MINUTES

When Mr. Sarnoff recently spoke before a meeting of the Electrical Society in New York he demonstrated, with the aid of radio apparatus on the lecture platform, the possibilities of inter-continental signalling by establishing contact with England, France and Germany in less than four minutes each.

A Condenser-Antenna For Indoor Use

A HOME-MADE indoor loop is usually not an attractive interior decoration and requires a comparatively large space to permit turning to point in the direction of the sending station. A condenser-aerial to take the place of the loop has been devised by a radio fan with an ingenious turn of mind. He writes:

The condenser aerial here described was installed in a house set in a clump of tall trees and partially shut in by hills rising one to two hundred feet higher than the roof of the house.

The flat tin roof, twenty-two feet above the ground, was first well grounded. On the second floor, which is about half-way between the roof and the ground, a woven wire copper screen, five feet wide by six feet long, was spread on the floor and covered by a rug. This screen forms the aerial; the ground wire for the aerial is connected to a water pipe.

It will be observed that the ground and roof form two outside plates of a large condenser, while the wire screen is the intermediate plate. The dielectric is made up of air, wood and floor coverings.

With this aerial and a simple set good

results are obtained regularly; in comparison with an outside aerial twenty-five feet high and one hundred feet long, the trouble from static is greatly reduced and the signal strength is good. But noting the setting of the tuner with the outside aerial, and then with the screen, when receiving from the same station, it was found that the natural wavelength of the screen is almost identical with that of a one-hundred-foot wire placed outside.

The efficiency of the screen aerial may be better judged when the simplicity of the set is considered. A single variometer in series with a fixed condenser with two taps is used for tuning: one tap of the condenser gives the variometer a range from 200 meter amateur stations to the 412 meter naval station at Anacostia; the second tap permits the 600 meter ship stations to be tuned in.

A single UV-201 tube is used for a detector and the plate circuit is tuned with a second variometer. Each variometer is made of two cardboard tubes carrying eighty turns of wire—forty turns on each tube.

With this simple set the following stations have been picked up regularly during July and August, except on two occasions when local electrical storms were extremely severe: WJZ, 150 miles; NOF, 300 miles; KDKA, 350 miles; WWJ, 450 miles. WGY, twenty miles away, comes in so clearly that the announcer's breathing can be distinctly heard.

The only disadvantage so far observed is that the body capacity of a person walking over the screen affects the tuning; this effect, however, is not noticeable when anyone on the lower floor passes under the screen.

The size of the screen does not appear to be critical except that if it is made too small it does not pick up sufficient energy. In experimenting with a small screen about three feet square it was possible to get the carrier waves from the various broadcasting stations, but the voice could not be distinguished.

T. A. Bryson

* * *

A Home-Made Connecting Block for Extra Headphones

ALL you will need, if you want to make your connecting block yourself, is a piece of bakelite, a small phone condenser and binding posts, the expense of which is less than twenty-five cents. Then follow these directions given by a New Jersey radio fan which are illustrated diagrammatically in the figure shown on this page:

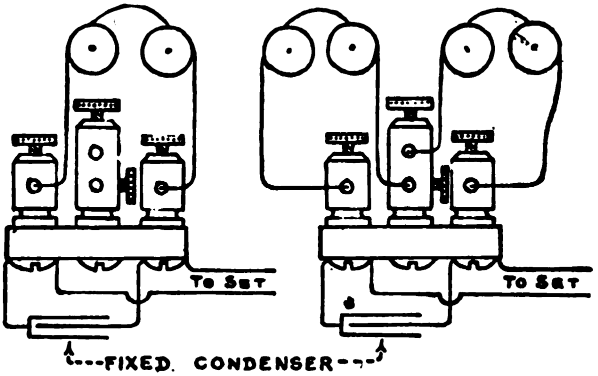
When more than one set of phones is used with a receiver, they should be connected in series. It is best to shunt a small fixed condenser across the circuit, as shown in the diagram.

The block for connecting the two sets of phones is fitted with three binding posts, which are mounted in a straight line. The central post is of the two-hole type and is left "blind": it is not connected in the circuit. The two end binding posts are of the ordinary type and are connected in the circuit in the usual manner. The posts are spaced about ¾ inch apart, and the fixed condenser is connected across the two outside posts.

When only a single pair of phones is used, they are connected to the end posts as shown at the left of the diagram, but when two sets are used, the connections are made as shown at the right.

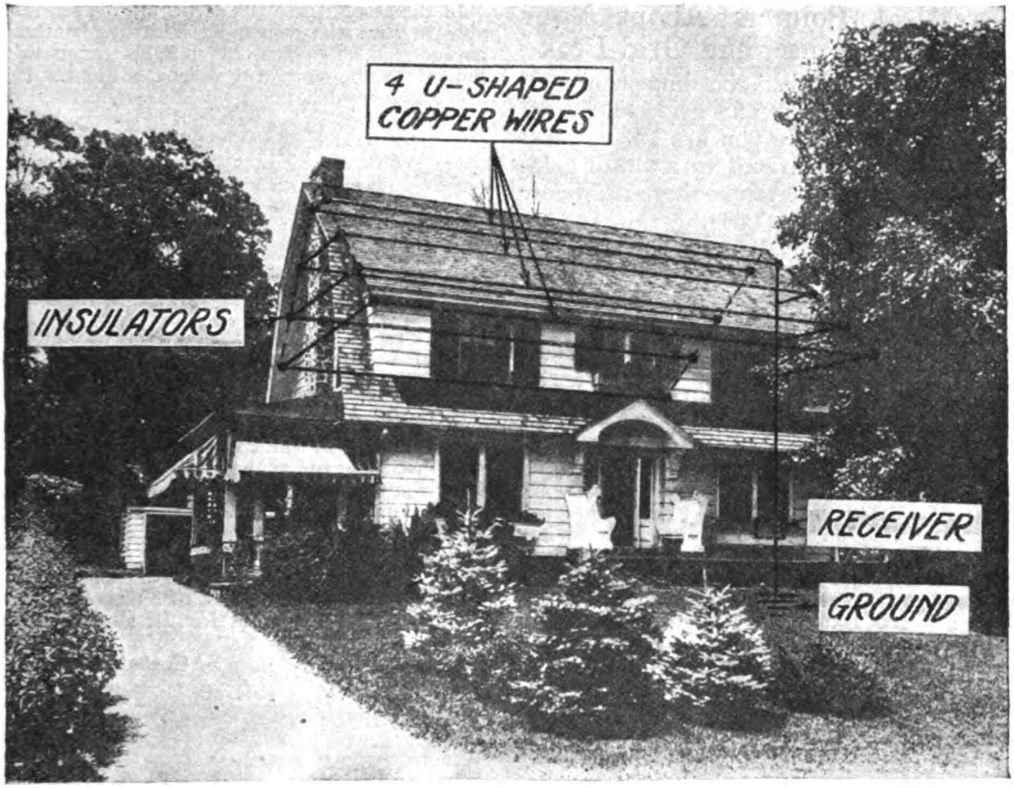
More than two sets of phones can, of course, be provided for by using the desired number of "blind" posts mounted in the same manner.

W. C. Michel



YOU CAN MAKE IT YOURSELF FOR A QUARTER

A small square of insulating material, three binding posts, a small fixed condenser and a few minutes' work, and you have a neat and compact block for connecting your headphones.



From a diagram made for POPULAR RADIO

No more troublesome and unsightly outdoor antennae will annoy the amateur who rigs up his wires under the rafters in his attic—secure from so many of the dangers that threaten the fan's exposed aerial.

An Indoor Aerial with a Crystal Set

AN ingenious radio fan in Elizabeth, New Jersey, finds it impractical to string up an outdoor antenna. So he has solved the problem of a successful indoor aerial for use with a crystal set, thus:

> Crystal sets will work satisfactorily with a properly designed indoor aerial, despite the word of "experts" to the contrary. The sets should not, however, be used with a loop antenna.
>
> My house is about fifteen miles from the New York City stations, WEAF, WBAY and WWZ, seven miles from WJZ and about five miles from WOR, WAAM and WBS. At the south end of my attic I put up an insulator and fastened a wire which was, of course, dead ended. I carried it to the other end of the attic to an insulator, carried it horizontally a distance of six inches across to another insulator and back to the end where I began, thence down to the set on the second floor. This was done with four wires fastened on the slanting roof, one below the other a foot apart, making thus four "U" aerials, all joined to one lead-in. The diagram shows how the wires were strung.
>
> By the use of galena or silicon in several different detectors (including home-made ones) I get all the broadcasting stations in the Metropolitan district, some amateur phones and plenty of 200 meter and 600 meter code. As I get the New York City stations but not WHN or WRW, which are twenty-five to thirty miles away, apparently my range with these four "U" pairs is about fifteen miles. I am of the opinion that more pairs would increase the range as well as the signal strength.
>
> With a honeycomb regenerative hook-up, using one stage of amplification and a Baldwin phone, this aerial will pick up enough energy to operate a phonograph used as a loudspeaker.
>
> In cases where it is impossible to set up an outdoor antenna but where there is an attic or other place for the stringing of at least two "U" pairs, and if the location is within fifteen miles of a broadcasting station, this indoor aerial certainly is worth trying on a crystal set.

GUY M. CHASE

Practical Pointers About Your Grid Condenser and Grid Leak

DON'T overlook the importance of your grid leak and grid condenser! Perhaps the trouble you are having with your set may be traced to a cheap grid-leak-condenser; certainly there are many such on the market. How this trouble may be avoided is here pointed out by an old-time amateur:

Two friends of mine who recently installed their first vacuum tube sets have both had trouble from the same causes—defective grid leaks or grid condensers.

In the first case the new set simply did not function. The hook-up was gone over several times, but nothing wrong was found. The tickler and battery connections were reversed; a new ground connection was tried; a new "B" battery was purchased in the belief that the first one was run down, but there was no improvement. I went through the routine of testing for him, and by a process of elimination, I arrived at the conclusion that the fault was in the grid-leak-condenser—a combination affair that he had purchased for about ten cents. There was no need to go further.

In the second case the owner of the set was able to hear the nearby broadcasting stations as soon as he hooked up, but his range was limited to the powerful nearby stations. He also had a combination grid-leak-condenser, but the trouble was found to be not in the condenser but in the grid leak. When another grid leak, made with two binding posts mounted on a piece of fibre and connected with a pencil line, was shunted around the condenser, a great improvement was at once noticeable.

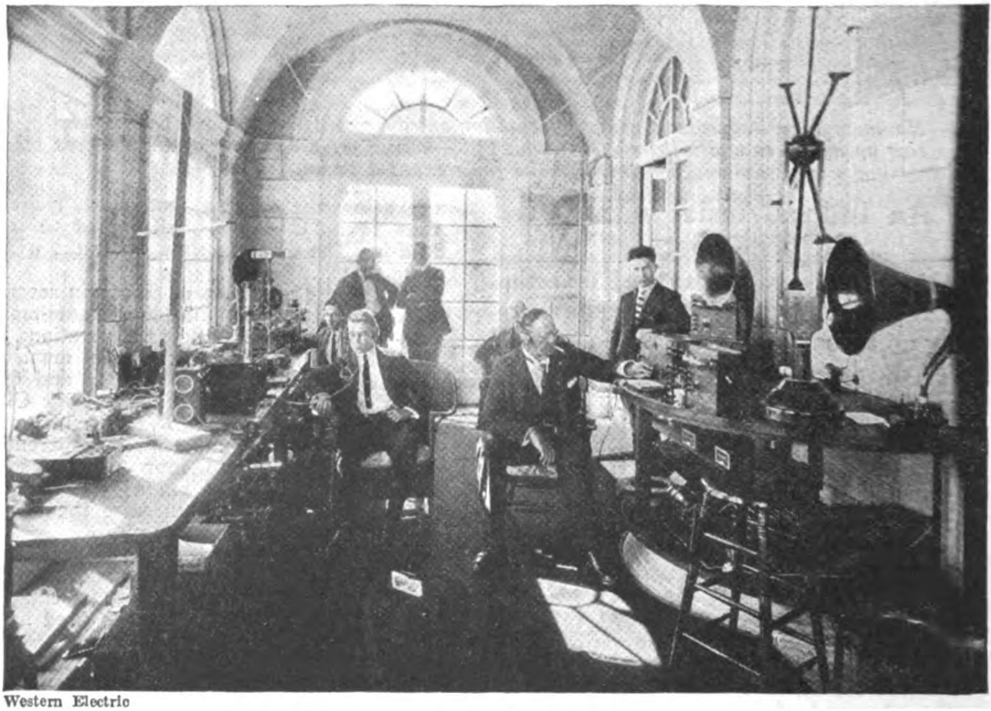
A new and reliable mica grid condenser and leak was finally installed in his set and the trouble which had been given him was remedied immediately.

The first night after we made this change we were able to pick up WGY at Schenectady, 175 miles distant, and a few minutes later KDKA at Pittsburgh, 330 miles distant.

To satisfy our curiosity we ripped apart the combination grid-leak-condenser that we originally used and found that the pencil line in the lead was not continuous, due to the rough surface of the fibre on which the line had been drawn; in other words the pencil only "hit the high spots" of the fibre.

Get a good mica condenser of about .0003 mfd. and a reliable grid leak of 2 megohms and watch your set reach out for the long distance stations.

S. GORDON TAYLOR



Western Electric

ONE OF THE MOST COMPLETE AMATEUR STATIONS IN AMERICA

To advance the radio art, Col. Edward H. R. Green has just completed a remarkable experimental station, WMAF, on his estate on Buzzards Bay, Mass., where he will afford facilities for fans who show promise of making real contributions to science. "No loafers wanted," he warns. "A real inventor does his best work nights and Sundays."

BROADCASTS

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

1,500,000 Sets Owned by American Fans

SOME idea of the rate at which the public interest in radio is "dying out" may be derived from the figures computed by a recent canvass of the country, which indicates that there are now approximately 1,500,000 receiving and transmitting sets owned by radio fans—exclusive of the commercial and governmental apparatus. The center of interest is Pittsburgh, where there is one set to every six houses.

* * *

A Scheme for "Taxing" Outdoor Aerials

THE solons of the City Council of Chicago have apparently been reading about the custom observed by European governments of imposing taxes on amateur sets, and are considering an ordinance that will put a tax of $3.00 a year on receivers and $5.00 on transmitters—in the form of a fee for inspecting outdoor antennas. What will happen when the outdoor antenna is supplanted by the indoor aerial?

* * *

Let the Radio Waves Do Your House-Work!

GEORGE FRANCHETTE, president of the "Society for the Study of Wireless," in France, has just put to domestic service the radio station on the Eiffel Tower. At six o'clock in the morning the radio waves from the tower set his alarm clock going, operate apparatus that closes his windows, turn on the heat and begin boiling his morning cup of chocolate.

* * *

How Radio Is Growing Abroad

THE rapid and inevitable growth of radio abroad is convincingly demonstrated by the government reports which show that the value of radio apparatus exported from the United States in 1922 just about trebled that of goods exported in 1921. Orders during 1922 came from practically every country in the world.

* * *

Radio Matriculates at Yale

DR. LEE DE FOREST, a graduate of Yale University, has established a fund at his alma mater for the purchase of a radio library, another fund for the giving of lectures on radio to advanced engineer students.

Noon and Midnight Time Signals "Interfere"

As Dr. Einstein points out, time is relative, after all, and noon and midnight occur simultaneously at opposite sides of the globe. So it is that radio operators on the Pacific can tune in on the midnight signals from the Honolulu station NPM, and by a quick adjustment can pick up the noon signals sent out from the station POZ in Nauen, Germany.

* * *

The Chief "Reform" Needed in Radio

"FEWER and better broadcasting stations" was the gist of the replies to a questionnaire sent out by the National Radio Chamber of Commerce to fans, dealers and manufacturers.

Kadel & Herbert

THE BELL OF STATION WOR

Fans who have heard the delightful notes of the chimes of the famous Newark station may here see not only this instrument, but also the capable Miss J. E. Koenig, the Manager.

Grand Opera Stalls at Home

Grand opera is now being broadcast in England. Some of the performances at Covent Garden, long the home of this form of musical entertainment in London, are being sent out on the ether by arrangement with the British National Opera Company, in the same manner as the grand opera performances have been broadcast from the Auditorium in Chicago during the past two years and more recently in Philadelphia.

Only the Metropolitan Opera Company in New York still refuses to broadcast programs.

* * *

A Move for Standardizing Radio Parts

At the request of six of the foremost organizations of radio engineers and manufacturers of and dealers in radio apparatus, the U. S. Bureau of Standards called a conference in New York on January 12th with the main purpose of considering whether or not radio apparatus should be made in standardized designs and, if so, how this standardization could best be brought about.

The action of the conference may be summarized by stating that it agreed unanimously:

1. That standards for radio apparatus and service should be formulated.
2. That a broadly representative national committee on radio standardization should be formed under the leadership of the Institute of Radio Engineers and the American Institute of Electrical Engineers, following the procedure of the American Engineering Standards Committee.

* * *

A Transmitting Station on Wings

Aircraft are now following ships in the utilization of radio equipment to add to the safety of the passengers. The first airplane to be licensed as a "limited commercial station" for both transmitting and receiving was the *Airline Arrow No. 1*, of the Airline Transportation Company of Los Angeles. Others are following suit. It is probable that radio will be extensively used in aircraft, especially in those which make flights over the ocean.

* * *

How Many Broadcasting Stations Can the Ether Hold?

January, 1923, was the first month since the beginning of the broadcasting wave that fewer new stations were licensed than were dropped out. This has been interpreted as an indication that 570 licensed broadcasting stations in the Class A and B groups constitute the saturation point, so far as numbers of stations is concerned; from now on the competition will be in quality. A new station, if it is to succeed, will have to offer better service than the old stations.

* * *

The Navy Clears the Ether

Largely because it does not wish to interfere with radio traffic, the Navy is closing several stations following the recommendations of the Rodman Board. The stations already closed are at Cape May, N. J.; Grande Isle, La.; Navassa, W. I.; Pass a Loutre, La., and St. Petersburg, Fla. A station at Seattle will be abandoned as soon as the Navy Yard at Puget Sound can take over the work. Stations at Baltimore, Md., Mobile, Ala., Miami, Fla., and Port Arthur, Texas, will be auctioned as soon as invitations to bid can be sent out. The station at Managua, Nicaragua, will be disposed of when arrangements for commercial facilities have been made. Ten stations in the Great Lakes have been offered to the Army.

* * *

Gold in Antenna Wires

The latest trick for the improvement of radio apparatus is to use gold-plated wire in the antenna. Gold-plated wire does not corrode; its use, therefore, eliminates the high skin resistance which is caused by corrosion.

"MENUS BY MAGIC"

Every morning Miss Florence Davis broadcasts from station WWJ in Detroit daily hints for the housekeeper whose job it is to select the food for dinner which explains why she receives so many letters from grateful husbands!

"STATIONS I HAVE HEARD"

IF *you are getting good results with your receiving set, tell your fellow-readers of* POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

A REMARKABLE CRYSTAL SET

THE simplest type of crystal set, using a loose coupler, is bringing programs from WOC in Davenport, Iowa, to Toledo, Ohio. Walter Brimmer, fourteen years old, made the coupler himself, from plans published in POPULAR RADIO, using 100 turns for the primary, tapped in tens and units, and 80 turns for the secondary, tapped in tens.

His aerial is a single wire, 85 feet long and 35 feet high. He also hears WWJ, Detroit, Mich., KDKA, Pittsburgh, Pa., and a Cleveland station. Interference is easily tuned out with the coupler, which is one of the best tuning instruments for a crystal set and even for the more complicated tube sets.

* * *

A ONE-TUBE SET THAT SPANS THE CONTINENT

WITH one vacuum tube, Harry K. Larson of San Francisco hears New York concerts plainly; he also hears most of the other stations in the United States.

The ultra-audion single tube hook-up is used in this set with the exception that the grid leak is connected to the negative of the "A" battery, enabling one end of the secondary coil to be connected to the grid and the other to the plate. The coil in this case was a variocoupler with a variometer in the antenna circuit. A 43-plate variable condenser is also included in the secondary circuit.

As local conditions do not permit the erection of a long antenna, Larson uses three strands 50 feet long and 35 feet high.

* * *

AN ORDINARY DETECTOR TUBE HOOK-UP THAT PICKS UP BOTH CANADA AND CUBA

STATION CFCF, Canada and PWX, Cuba can be heard in Atlanta with the ordinary detector tube hook-up, according to H. L. Grosbeck, who has heard some 90 stations with such a set.

The set is home-made, of the regenerative type, with a variocoupler, two variometers and variable condenser.

Grosbeck attributes his success to his cage aerial, which is 12 inches in diameter, with 6 wires 60 feet long, and 50 feet high.

* * *

A USEFUL COUNTERPOISE

A COUNTERPOISE is given credit by John E. Carson of Pittsburgh for bringing in signals from Los Angeles with one tube. Carson explains that his success came after considerable experimenting with the regenerative circuit. Many arrangements which brought startling results to others would not work as well for him as some less complicated systems.

His antenna is made of three strands, 110 feet long and 60 feet high. The counterpoise has three strands of similar length which are run 8 feet above the ground.

The set brings in California regularly, as well as Denver, Colo., Winnipeg, Canada, Havana, Cuba, and scores of others in between.

* * *

AN AERIAL ON A TIN ROOF

AN aerial but 40 feet long and 15 feet above a tin roof gives one tube a range of half the continent in the set of Homer Brewster in Brooklyn. The aerial is in the form of an inverted L, with 4 wires 35 feet from the ground.

Brewster uses two variometers in his regenerative hook-up and 48 volts on the plate of his detector tube.

Stations WDAP, Chicago, WOC, Davenport, Ia., WHB, Kansas City, Mo., and WGM, Atlanta, Ga., are heard regularly and clearly.

* * *

A SINGLE CIRCUIT COVERS 1,800 MILES

WITH only one tube in a single circuit regenerative set, George R. Worth of Chicago has heard Los Angeles, Calif., which is 1,800 miles away. He also hears Dallas, Tex., and the larger stations of the Eastern coast under favorable circumstances. Four strands are used in his aerial, which is 160 feet long and slants from an altitude of 55 feet to 40 feet.

* * *

DRY-CELL TUBES AMPLIFY

Three dry-cell tubes bring in New York and Atlanta, Ga., for Arthur F. Walker of Boston, Mass., as well as a number of stations closer to him. He uses a single circuit regenerative set with two stages of audio frequency amplification. His aerial is made of two wires about four feet apart, 30 feet high and 80 feet long.

* * *

WHAT ONE FAN ACCOMPLISHES WITH TWO VARIOMETERS

With the use of two variometers and a single tube, on clear nights Milton F. Conklin of Cincinnati, O., receives from KGW in Portland, Ore., more than 2,000 miles away.

His set is used with a three-strand antenna 140 feet long and 35 feet high.

* * *

A FREAK *RICOCHET*

Covering the distance from Chicago to New York with a crystal set startled Rockaway Beach, N. Y., until the strange feat was explained by Frank J. Bennett, whose regenerative set first caught the waves and relayed them to his friend next door. Bennett's aerial is 200 feet long and runs parallel with that of his friend, which is 50 feet distant.

* * *

International

THE WORLD'S BEST HOME-MADE SET—FOR THE MONEY

The universal success of the $11.00 to $15.00 crystal receiver developed by the Bureau of Standards for the special benefit of amateurs who "build their own" is proclaiming it as a standard of excellence. Its usual range is fifteen miles, but it has on occasion received up to 1,000 miles.

A JERSEY FAN PICKS UP CUBA WITH DRY-TUBE CELL

Stationed in Newark, N. J., L. S. Fisher hears PWX, Havana, Cuba, with a dry-cell tube that requires but 1½ volts to light the filament. He uses a variocoupler and one 43-plate condenser.

The antenna used is a single wire, 140 feet long. It is pointed in the direction of Cuba, which accounts in part for the performance of the tube. The wire is 55 feet from the ground. The ground connection is made in the usual manner to a water pipe.

* * *

NEW YORK HEARS PORTO RICO ON A SINGLE CIRCUIT RECEIVER

Seventeen stations more than 250 miles away are heard with a dry cell tube and single circuit tuner by Allen Berman of New York City. His record for distance is WKAQ, San Juan, Porto Rico.

The aerial is made of two strands 120 feet long and 60 feet high. This forms a fairly good antenna for any kind of set. With the little dry-cell tube it brings in most of the large eastern stations.

* * *

AN AMATEUR SET REACHES 1,000 MILES ON TWO TUBES

With one stage of audio-frequency amplification, James A. Carver has heard 43 stations in 17 different states. He lives in Philadelphia and his record in reception is from WBAP, Fort Worth, Tex., over 1,000 miles away.

The set consists of a variocoupler, variometer, variable condenser and the two tubes. The aerial is a single wire 110 feet long and only 20 feet above the ground. The range of the set could be considerably increased by raising the aerial, but it is possible that this form is fairly well suited to local conditions.

* * *

A 30-FOOT INDOOR ANTENNA

With a single wire 30 feet long strung inside his home, Austin F. Milford of Fort Worth, Tex., receives from Denver and Kansas City by using two stages of audio frequency amplification. His set consists of the ordinary variocoupler, variometer, and 43-plate variable condenser.

* * *

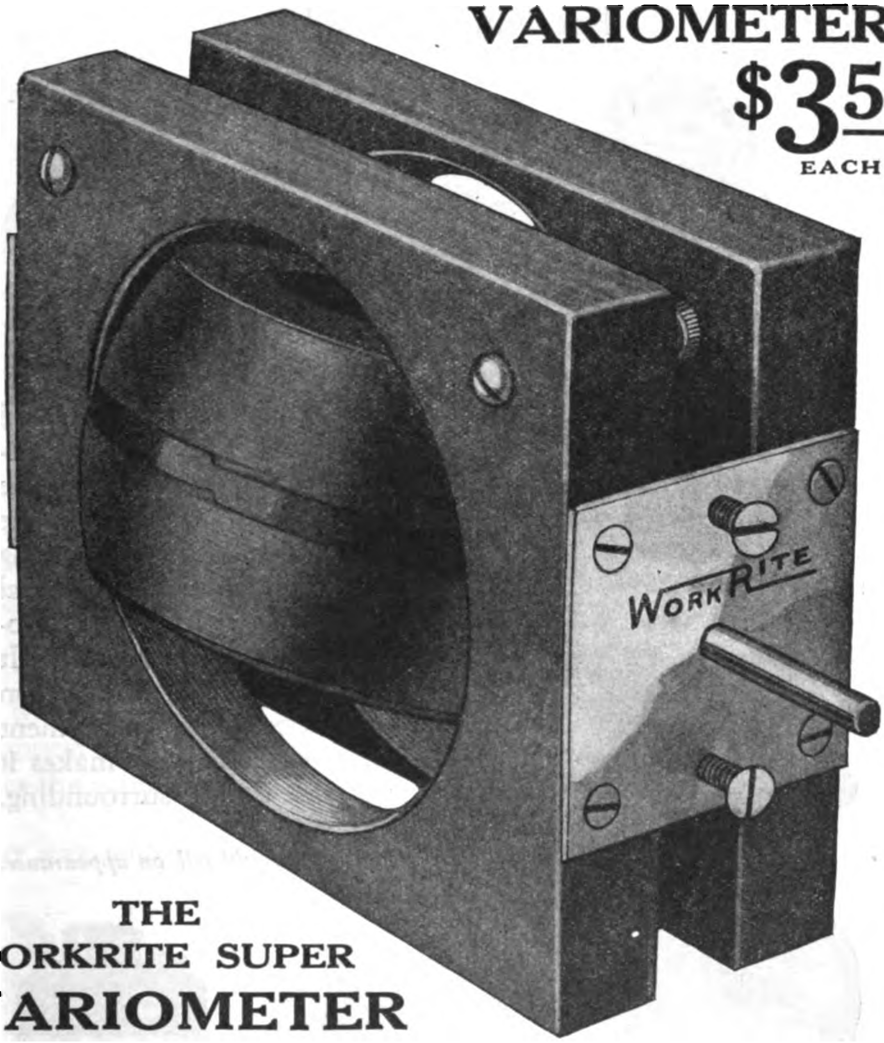
A SINGLE CIRCUIT COVERS 1,800 MILES

With almost the worst possible local conditions, James F. Vincent in Chicago hears New York stations regularly with one tube. His antenna is only a single wire, 100 feet long, running parallel to a 5,500-volt power line, a house circuit and several telephone wires. The telephone wires come within five feet of the antenna at one point.

A regenerative hook-up is used with two coils, a primary coil with 50 turns and a tickler coil with 25 turns. The set is tuned with the tickler and a condenser in the antenna circuit.

NEW LOW PRICES ON
"WORKRITE"
VARIOMETERS

$3.50
EACH



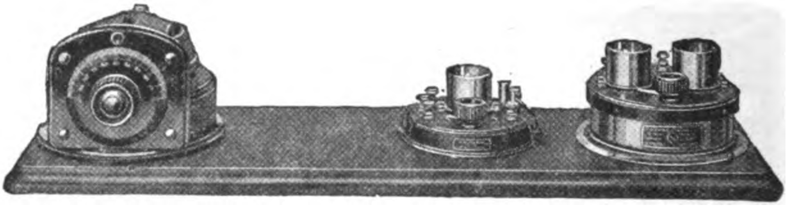
THE
WORKRITE SUPER
VARIOMETER

represents the family of WorkRite Radio Parts. Exceptionally well made from genuine mahogany. Has just the right number of turns and air space to make it very sensitive and sharp to tune. Two WorkRite Super Variometers and one WorkRite Super 180° Variocoupler make the famous WORKRITE TUNER TEAM the most selective circuit obtainable. The price of these instruments has been reduced from last spring's price of $6.00 to $3.50 each now. Order your set right away, and ask for catalog of complete line of "WorkRite" parts.

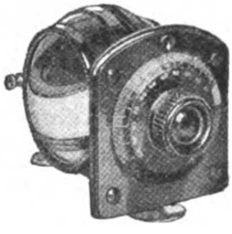
THE WORKRITE MANUFACTURING CO.
(Branch Offices, 2204 Michigan Ave., Chicago) 5506 Euclid Ave. Cleveland, Ohio

ATWATER KENT

Receiving Sets and Parts



Complete Set consisting of Coupled Circuit Tuner, Detector Unit and 2-stage Amplifier. Other sets shown in circular

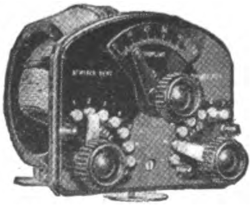


Mounted Variometer

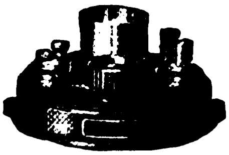
Type 11 Tuner

ATWATER KENT Receiving Sets and Parts are built with the most particular care. From the moulding of the condensite forms and winding of the various coils, through the assembling and finishing of the units to the final mounting and wiring, every step is subjected to the most rigid inspection. It must be "just so." This is the reason why ATWATER KENT radio equipment has that "different" look that makes it instantly noticeable in any surrounding.

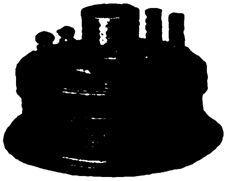
Atwater Kent products would sell on appearance.



Mounted Variocoupler



Detector Unit



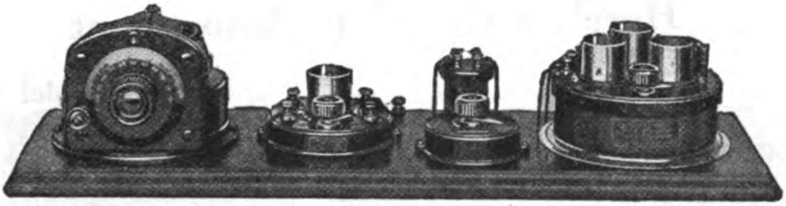
1-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

ATWATER KENT

Receiving Sets and Parts

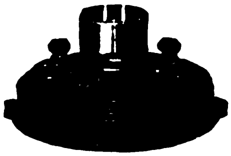


Complete Set consisting of Type 11 Tuner, one stage of Radio Frequency Amplification, and Detector 2-stage Audio Frequency Amplifier

BUT appearance is not the only feature that is watched. Even though the factory is pushed to its utmost capacity by the extraordinary demand for ATWATER KENT sets and parts, every unit is carefully tested to make certain that its performance is right. By this means, the radio fan is sure of getting a part or set that is not only strikingly handsome in appearance, but works perfectly, and gives the utmost satisfaction.

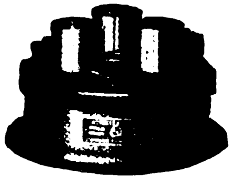
They stay sold on quality of performance.

R. F. Transformer



Standard Vac. Tube Unit

Detector 1-stage Amplifier
A similar unit is furnished in a 2-stage Amplifier



Detector 2-stage Amplifier

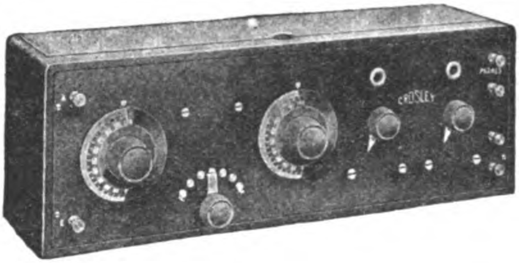
Potentiometer

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

For Radio Frequency Sets

Constantly Making New Distance Records
Here's a Complete Assortment



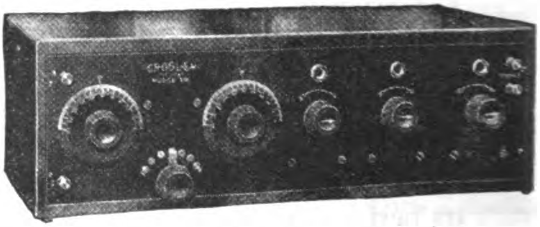
Crosley Model VI

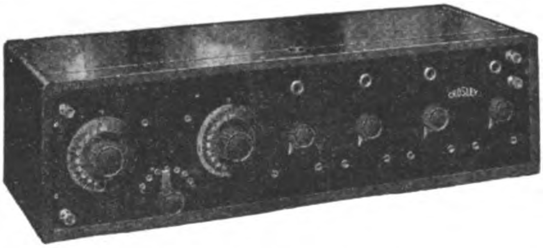
This set consists of one stage of Tuned Radio Frequency Amplification and Audion Detector. It is normally for use with head phones but is especially recommended to be used with any type of loud speaker. Additional amplification is unnecessary if head phones and horn are used in receiving local stations. With the Crosley Receiver Model VI distant broadcasting stations are brought in loud and clear. It also eliminates static to a large extent.

Mounted on formica panel, Adam brown mahogany finished cabinet without tubes, batteries or phones. Price.......... **$30.00**

Crosley Model VIII

A new set offering exceptional value. Contains one stage of tuned radio frequency amplification, detector and one stage of audio frequency amplification. Also offered as a portable instrument, using 1½-volt tube. Price, without batteries, tubes and phones, Regular Model VIII, **$48.00,** Model VIII, Portable **$60.00**





Crosley Model X

The most complete receiving set on the market. A 4-tube set consisting of one detector, one stage of tuned radio frequency and two stages of audion frequency amplification. In placing this receiver on the market, we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can compare with it at twice the price. Developed in the CROSLEY laboratories, this unit is absolutely the last word in long range Radio Receiving Apparatus. Used with head phones and loud speaker, it will bring in distant stations all over the house. Price without phones, batteries or tubes **$55.00**

Crosley Receivers

From our smallest complete receiving outfit at $25, including other sets incorporating Crosley radio frequency tuned amplification at $28, $48, $55, and up to our beautiful Console Model XXV, price $150, Crosley instruments offer the highest efficiency at the lowest cost.

CROSLEY
Better—Costs Less
RADIO RECEIVER

Crosley Parts

We also manufacture a complete line of parts for those who wish to make their own outfit. Among these are Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario-Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

CROSLEY MANUFACTURING CO.
416 ALFRED ST. CINCINNATI, O.

Crosley ACE

Regenerative Receivers

$20.00 and up

ANNOUNCEMENT

Powel Crosley, Jr., President of the Crosley Manufacturing Company, has acquired controlling interest of the capital stock of The Precision Equipment Company, of Cincinnati, licensed to manufacture regenerative apparatus under Armstrong Patents. Crosley management, production and sales methods already have enabled us to offer even better apparatus at lower prices.

Crosley Model V Regenerative Receiver

Remarkable records are being achieved by owners of the Crosley Model V regenerative radio receiver, which is the greatest result-producing one-tube set being manufactured today. With a range of from 150 to 600 meters, this little wonder brings in amateur, broadcasting and commercial stations. Concerts broadcast more than 1,000 miles away are heard by those who own the Model V. The cabinets are arranged to permit use of the one and one-half volt tubes, with which they operate very efficiently. Use of these tubes eliminates necessity of buying more expensive "A" batteries. The name "Crosley" is used by permission of the Crosley Manufacturing Company. Made in two models. Both have Adam brown mahogany finished cabinets and beautifully engraved panels. The Crosley two-step amplifier matches this unit perfectly.

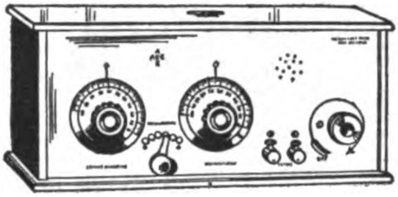
Model V-C $20.00
Model V-D 19.00

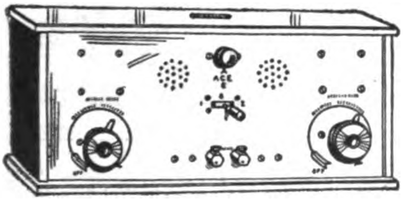
Model V-D has overhanging lid, otherwise it is the same as Model V-C.

ACE TRU

Regenerative Radio Receiver

No powerful station in the United States is too far away to be copied by owners of the Tru radio receiver. The cabinet of the Tru is beautifully finished, the panel is of genuine formica and all the parts are the most efficient obtainable. Without amplification, the Tru will bring in distant stations loud and distinct. In comparison with any of the highest quality instruments available, the Tru receptor will equal, if not surpass, the performance of any of them. If the owner desires to operate a loud speaker, an amplifier must be added, and we recommend the AV-2, illustrated below. Price of the Tru Receptor (formerly $65), now..........$35.00





ACE AV-2 Two-Step Amplifier

The AV-2 Two-Step Amplifier designed to be added to the Tru radio receiver, with which it matches perfectly, may be used in conjunction with any audion receiver. Ace type transformers and sockets are used in the AV-2. The cabinet is beautifully finished. The panel is of genuine formica. There is a switch permitting use either of one or two stages of amplification, and also special binding posts for the use of head phones in conjunction with a loud speaker. Experiments have shown that the amplification constant is approximately twenty times that of the incoming signal on the first stage and 400 times on the second. Price of the AV-2 (formerly $65) now..$35.00

ACE Tube Socket

A real good socket, built to stand long and hard service. There is no moulded base to melt when the soldering iron is applied. Instead this is of real sheet formica, one quarter inch thick. Substantial metal die casting—pure phosphor-bronze springs. This socket has been designed to prevent shortcircuiting and burning out of the expensive vacuum tubes. Prong contacts are carefully adjusted. One and one-half volt tubes may be used in these after adapters are inserted.

We recommend the adapters made by the Crosley Manufacturing Company.

Price $1.00

ACE Condenser

Capacity .0005 Mfd.

Exclusive features of this condenser are too numerous to dwell upon. These, however, include balanced non-warping plates, carefully adjusted, and a fine positive gear vernier, with a five to one ratio.

Price with Vernier.... $7.50
Without Vernier 5.00

ACE Transformer

Enormous amplification has been attained and foreign noises have been eliminated through use of the Ace transformer. A generous core of high-grade transformer iron supports rugged primary and secondary windings. The core, in turn, is supported by two nickel-plated cones, which permit of base or panel mounting. Plainly marked terminals through insulation bushings in the shell provide convenient connections in the circuit.

Price $5.00

Licensed under Armstrong U. S. Patent No. 1,113,149, October 6, 1914. For use by radio amateurs in radio amateur stations, to radio experimenters and scientific schools and universities, for use in experimental and scientific schools or university radio stations. The Crosley Manufacturing Company has discontinued the sale of regenerative radio receivers, but Crosley dealers will be able to supply you with those made by the Precision Equipment Company.

WRITE FOR CATALOG OF COMPLETE SETS

THE PRECISION EQUIPMENT CO.

POWEL CROSLEY, Jr., President

416 GILBERT AVE. CINCINNATI, OHIO

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

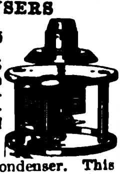
FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

P812—43 plate .001 Mfd. $2.29
P813—21 plate .0005 Mfd. 1.80
P814—11 plate .00025 Mfd. 1.32
P815—3 plate Vernier 1.05

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

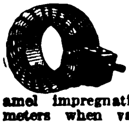
COMBINATION VERNIER VARIABLE CONDENSERS



P824—23 plate .0005 Mfd.
Price $3.25
P826—43 plate .001 Mfd.
Price $3.95

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning High-grade design and construction. Finely finished. Suitable for panel mounting.

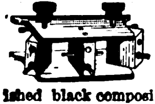
INDUCTANCE "HONEY COMB" COILS



Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	P301	$0.39	P320	$0.97
35	175- 450	P302	.42	P322	1.00
50	240- 720	P303	.49	P323	1.07
75	390- 910	P304	.54	P324	1.12
100	500- 1450	P305	.58	P325	1.16
150	600- 2000	P306	.63	P326	1.21
200	900- 2500	P307	.72	P327	1.30
250	1200- 3500	P308	.78	P328	1.36
300	1500- 4500	P309	.82	P329	1.40
400	2000- 5000	P310	.97	P330	1.55
500	2800- 6100	P311	1.12	P331	1.70
600	4000-10000	P312	1.27	P332	1.85
750	5000-12000	P313	1.43	P333	2.00
1000	7900-15000	P314	1.70	P334	2.38
1250	9750-19500	P315	1.92	P335	2.60
1500	14500-26500	P316	2.18	P336	2.76

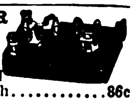
COIL MOUNTINGS



P340 Three coil mounting $3.59
P341 Two coil mounting $2.69

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil

GALENA DETECTOR



Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. P732 Each............86c

This Guarantee Protects You. Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

P105 Detector. Each....$4.45
P110 Amplifier. Each.... 5.95
P115 5 Watt Transmitter 7.70

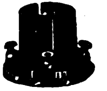
MYERS TUBES

P113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate Each $5.00
P116 Receptacle for above. Each... 1.00
P117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

MYERS CHOKE COIL

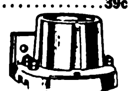
P119 Each...........................$3.50

VACUUM TUBE SOCKETS

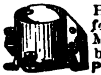


Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs
P140 Each.............39c

PORCELAIN BASE AND TUBE



P144 Crosley for either panel or table mounting 30c



High Grade combination type for panel or table mounting. Metal tube. Highly insulated base.
P146 Each...............45c

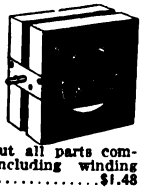
GRID CONDENSER

P162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF.........14c
P163 Same as 162 but higher grade. Enclosed in metal case......39c

VARIABLE GRID LEAK

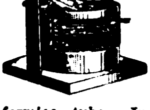
Pencil mark type. Resistance may be varied exactly as needed.
P100 Each..........18c

VARIOMETER



P410—Completely assembled, price $2.69
Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.
P411—Not assembled but all parts complete, except wire, including winding form $1.48

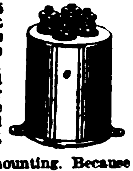
VARIO-COUPLER



With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

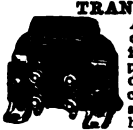
P415 Price, completely assembled $2.45
P416 Not assembled, but all parts complete. Price, except wire $1.18
P417 Rotor ball only. Each........29c

RADIO FREQUENCY AMPLIFYING TRANSFORMER



P995 Each.........$2.95
This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS



As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

P234 10 to 1 Mounted. Each......$3.48
P235 10 to 1 Unmounted. Each.... 2.95
P236 3 to 1 Mounted. Each...... 3.40
P237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

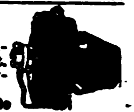
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
P130 Each...............54c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
P132 Each...............48c

POTENTIOMETER

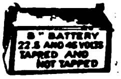
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
P133 Each ....[illegible]

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
P135 Each.............78c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

P180 Signal Corps type, small size, 15 cells, 22½ volts. Each, 95c.
P182 Large Navy size, 6½x4x3, 15 cells. 22½ volts. Each..................$1.75
P184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.............$1.[illegible]
P186 Double Navy size 6½x4x6, 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40
P188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each ....$3.[illegible]

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
P240—100 ft. coil 45c
P242—500 ft. coil $2.15

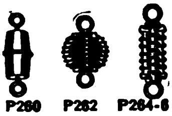
Solid Bare Copper Wire, size 12
P244—100 ft. coil 61c
P245—500 ft. coil $2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

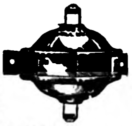
P248—100 ft. coil 65c
P249—500 ft. coil $2.95

ANTENNA INSULATORS



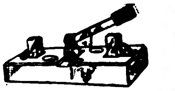
P260 Size 1x3¼. Two for.......17c
P262 Size 2⅛x3¼. Two for.......53c
P264 Size 1½x4. Two for.......89c
P266 Size 1½x 10½. Two for $1.35

OUTDOOR LIGHTNING ARRESTER



P980 Price.........$1.68
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

P385 Single Pole Single Throw. Each 20c
P387 Single Pole Double Throw. Each 32c
P384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

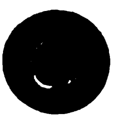
Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

P380—1" Radius
P381—1¼" Radius
P382—1½" Radius
Each 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
P386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB



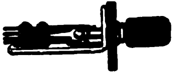
Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

P900 2¾" Diam. for 3-16" shaft. Ea..19c
P901 2¾" Diam. for ¼" shaft. Ea....19c
P904 3" Diam. for 3-16" shaft. Ea.....25c
P905 3" Diam. for ¼" shaft. Ea.....25c
P906 4" Diam. for 3-16" shaft. Ea....42c
P907 4" Diam. for ¼" shaft. Ea......42c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS



Finest grade jacks. improved design. Best materials Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅝ in. thick.

Jacks only:
P390 Open circuit. Each.....43c
P391 Closed circuit. Each....49c
P392 Two circuit. Each......60c
P393 Single-cir. fila. control..69c
P394 Two cir. fila. control..85c

P395 Plug. Large space with set screws for attaching cord. Each............54c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.

P387 Open Circuit Jack. Each......27c
P388 Two Circuit Jack. Each......35c
P389 Standard Plug. Each.........35c

BINDING POSTS

P370-2

P376-8

Brass, polished nickel finish. Washer and 6-32". screw extending ⅝"....

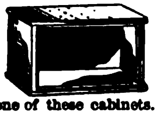
P370 Large size—barrel and knob ¾" long, dozen 85c
P372 Smaller size—barrel and knob 9-16" long. dozen 70c
P374 Large size with composition knob, dozen 60c
P376 Large size with hole for phone tip or wire, dozen.......................80c
P378 Small size with hole for phone tip or wire, dozen.......................38c

STORAGE BATTERY

A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.

P194 6-v., 40 amp. size. Each..$10.00
P196 6-v., 80 amp. size. Each....$12.50

CABINETS



Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	P420	$2.48
6x10½"	5½"	10"	7"	P422	2.75
6x14"	5½"	13½"	7"	P424	3.30
7x14"	6½"	13½"	7"	P423	3.60
7x18"	6½"	17½"	7"	P426	3.90
7x21"	5½"	20½"	7"	P425	4.20
9x14"	8½"	13½"	10"	P428	3.70
12x14"	11½"	13½"	10"	P430	4.40
12x21"	11½"	20½"	10"	P432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x7	P450	$0.50	P460	$0.75	P470	$0.98
6x10½	P451	.75	P461	1.18	P471	1.47
6x14	P452	1.05	P462	1.55	P472	2.05
7x14	P458	1.20	P468	2.60	P478	2.40
7x18	P453	1.55	P463	2.30	P473	3.10
7x21	P457	1.78	P467	2.65	P477	3.60
9x14	P454	1.60	P464	2.30	P474	3.10
12x14	P455	2.10	P465	3.10	P475	4.15
12x21	P456	3.15	P466	4.65	P476	6.20

BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. **Prices are Transportation Paid.**

P201 For 6 volt battery..........$13.95

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

P770—2000 ohm......$4.00

OTHER STANDARD BRAND HEADSETS

P751 Murdock 56, 2000 ohm......$4.45
P752 Murdock 56, 3000 ohm...... 4.95
P764 Frost 2000 ohm............. 4.20
P766 Frost, 3000 ohm............ 4.95
P756 Red Head, 3000 ohm........ 5.85
P758 Western Electric, 2200 ohm.. 9.50
P754 Baldwin Type C with universal jack plug $12.00
P755 Baldwin Type C unit...... 5.50
P768 Brandes, 2000 ohm......... 7.15
P789 Holzer-Cabot, 2200 ohm.... 7.20

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

Kellogg Radio Equipment for Better Results

Use, Is the Test

HEAD SETS

The value of extremely light and very small head sets in Radio receiving is most evident when using Kellogg head receivers, which, however, have proved as sensitive and thoroughly efficient as they are light in weight and small in size. The band, too, is especially adaptable and the simple receiver holders, which are held in place on the lower part of the head band by the spring tension of the metal, can be instantly adjusted so as to place the receivers over the ears for the best hearing.

No. 69A Head Set, 2400 ohms, each	$10.00
No. 69C Head Set, 2000 ohms, each	8.00
No. 74A Head Set (single), 1000 ohms, each	5.00

DIALS

All Bakelite. Non-warping, reinforced construction. 5-16 inch shaft with bushings for 1-4 and 3-16 inch shafts included.

No. 501 3 inch Dial	$1.00
No. 502 4 inch Dial	1.25

Kellogg Radio jacks, plugs, condensers, variometers, tube sockets, dials, insulators, coils, variocouplers, microphones, etc., are the best that money can buy.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, CHICAGO

THE ACOUSTICAL AMPLIFIER

BEL-CANTO

TRADE MARK

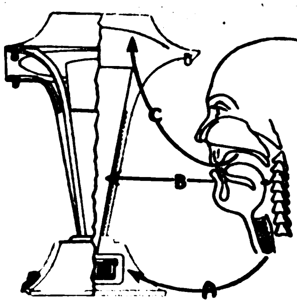
LOUD SPEAKER

Amplifies without Distortion

Built along scientifically correct principles, following minutely the natural functions of the human throat. The unexcelled acoustical amplifier!

The receiver is the vocal cord (A); the long tapering inner horn is the throat (B); and the sounding board at the top is the roof of the mouth (C).

With this superlative amplifier you can readily distinguish the delicate tonal differences between the harp and the piano, even when the two are playing together. A test never before equaled.



Is adjusted for regenerative two stages of amplification, also five tube radio and audio frequency.

Special phone, cord and plug, price $30.00 F.O.B. New York. If dealer can't supply, we can.

Full line of radio parts.

BEL-CANTO CORPORATION

417 East 34th Street **New York City**

PROGRESS

NATURALLY, at this early stage, the Art of Radio Communication is not standing still. It is undergoing a normal evolution.

The low-hung, straight line automobile of today is unlike its cart-like predecessor of twenty years ago, although the principle of locomotion remains the same.

So, too, the design of Radio apparatus advances. Insulated panels and live shafts are supplanted by metal panels and completely insulated instruments—the obvious thing to do, making unnecessary the use of a shield. Unsightly, protruding knobs are replaced by recessed dials and straight tuning bars, permitting fine adjusting without cramping the hand. The tap switch is removed entirely from the panel and becomes an integral part of the variocoupler, being placed *inside* the rotor, thus eliminating all soldering of primary leads.

It is significant that all these improvements have been developed in the Eisemann laboratories.

Descriptive literature will
be sent upon request

EISEMANN MAGNETO CORPORATION
WILLIAM N. SHAW, *President*

DETROIT BROOKLYN CHICAGO

EISEMANN

Just Consider

—the essential features necessary to make an audio frequency transformer a good one—

1. *High Amplification.*
2. *Minimum Distortion.*
3. *Low Interstage Linkage.*
4. *Convenient Mounting.*
5. *Compactness.*

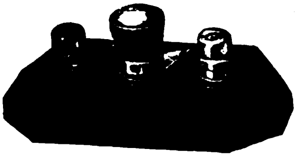
Cotoco transformers make these ideal features facts. And the finish will surely please you.

"Built First to Last"
$5.00
At Your Dealer's

COTO-COIL CO. **PROVIDENCE**

Pacific Coast Branch, 329 Union League Bldg., Los Angeles

FRESHMAN PRODUCTS—ACCURATE AND DEPENDABLE

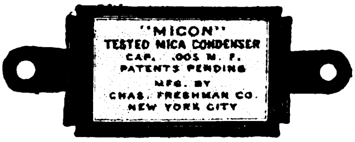


VARIABLE RESISTANCE LEAK

With .00025 mfd. MICON Condenser Combined **$1** Without Condenser **75c**

Unbroken range—Zero to 5 Megohms—Clarifies signals, lowers filament current, increases battery life, eliminates hissing.

"MICON" Tested Mica CONDENSERS



Size	Price
.00025	$ .35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.006	1.00
.01	1.50

Assure absolute noiselessness—clarity of tone—accuracy—constant fixed capacity.

.006 Micons and Variable Resistance Leaks, especially adapted for New Flewelling Super Circuit.

ANTENELLA

No antenna or aerial needed. Eliminates all the inconveniences in radio, operates from any light socket. Price only $2.00.

$2

At your dealer's—otherwise send purchase price and you will be supplied postpaid.

CHAS. FRESHMAN CO., Inc.
106 SEVENTH AVENUE NEW YORK

How much do you expect your battery to do?

TURNING the dials with a battery that is a constant offender is not much fun. You cannot thoroughly enjoy radio broadcastings unless your battery is up to the job.

Exide Radio Batteries are conservatively rated and give full ampere-hour capacity. They maintain steady voltage and deliver uniform filament current to the tubes. From plates to connector terminals each detail is the result of experience gained in every field of battery service by the oldest and largest makers of storage batteries in the world.

Exide Batteries play a leading role in the industrial world. They propel trucks, mine locomotives, and submerged submarines; they operate the fire alarm system and send your voice over the telephone. Most of the government and wireless commercial stations are equipped with Exide Batteries.

Your radio dealer will show you an Exide Radio Battery, or you can get one at any Exide Service Station.

Exide
BATTERIES

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia, Pa.

Service Stations Everywhere
Branches in Seventeen Cities

$45.00

CHELSEA REGENERATIVE RECEIVER

A Real Broadcast Receiver

Range 150 to 800 meters

- ¶ **Perfection in design**
- ¶ **Pleasing appearance**
- ¶ **Simple and accurate tuning**

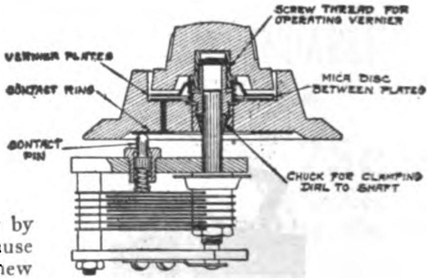
A Chelsea product, embodying Chelsea equipment throughout. Licensed under Armstrong U. S. Pat. No. 1113149. For amateur use only.

Write for our new No. 7 Catalogue

CHELSEA RADIO COMPANY

177 Spruce Street **Chelsea, Mass.**

HERE! The New "UNITED" VERNIER DIAL ASSEMBLY


SCREW THREAD FOR OPERATING VERNIER
VERNIER PLATES
CONTACT RING
MICA DISC BETWEEN PLATES
CONTACT PIN
CHUCK FOR CLAMPING DIAL TO SHAFT

An electro engineering triumph which attains a hitherto impossible fineness and selectivity of tuning.

The ordinary condenser, in conjunction with the human hand, is faulty—even crude—that is the reason distant stations cannot be tuned in at will. The air is always full of signals, but many times you pass right by a most desirable concert from a far away station because you are not able to tune fine enough to bring it in. Our new Vernier Dial Assembly can be attached to any plate type Condenser on the market, and has given, in actual practical tests, twice as fine adjustments as any 3-plate Vernier. It makes possible that infinite precision in tuning which every radio fan desires.

Circuits in the dial are separated by a mica insulated gap between large area copper plates. Vernier adjustment is controlled by small knob operating a delicate screw thread. Large knob controls plate motion.

Like all "United" Radio products, this new Vernier dial assembly is a fine example of accurate workmanship from an $800,000 plant equipped with the latest precision tools and backed by a staff of trained radio engineers and experts. Price of Vernier Dial Assembly, each....................$2.50

Send for Bulletin.

"UNITED" CONDENSER with Vernier Dial Assembly

43-plate - each $6.50 23-plate - each $6.00 11-plate - each $5.50

Also ask for information and prices on our plain Variable Condensers.

UNITED AUDIO FREQUENCY TRANSFORMER

Magnetically shielded, ratio 5 to 1.

Adopted as standard by leading manufacturers—$4.50.

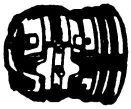
UNITED MFG. & DISTRIBUTING CO. 536 Lake Shore Drive, CHICAGO

Elegance and Scientific Precision Combined!

YOU will welcome a Kennedy Receiving Set in your home. Its distinguished appearance lends itself to the most refined surroundings and outwardly reflects the accuracy and precision exercised in its manufacture.

In a cabinet of beautifully finished hardwood and mounted behind a richly polished panel you will find a series of precision instruments—each correctly designed in itself and each exactly co-ordinated with the balance of the set.

Ease of control, long distance reception, elimination of interference and the utmost pleasure and satisfaction in its use are assured with a Kennedy receiver.



The Kennedy Variometer

This, as well as all other parts, is scientifically constructed by Kennedy artisans. The minute clearance between rotor and stator, the firm windings and positive contact eliminate dielectric losses and increase sharpness of tuning.

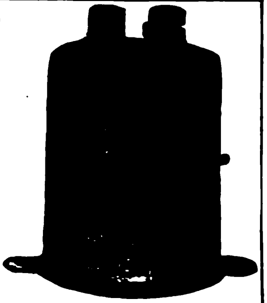
Arrange with your Kennedy Dealer for a demonstration. Or write us direct for further information.

THE COLIN B. KENNEDY COMPANY
SAN FRANCISCO SAINT LOUIS

KENNEDY

The Royalty of Radio

Widen the Range of Your Radio Receiver and Get All Signals Clearer



Clear, powerful long-distance radio reception is chiefly a matter of *amplification.* By equipping your receiving set with

"All-American" Amplifying Transformers

(RADIO and AUDIO Frequency)

you add wonderfully to the power and range of reception. Signals ordinarily so faint that they can be heard only thru headphones come in clear and strong thru any good Loudspeaker.

R-10—Radio Frequency (150-500 meters) $4.50	R-13—Audio Frequency (Ratio 10 to 1) $4.75
R-12—Audio Frequency (Ratio 3 to 1) . 4.50	R-21—Audio Frequency (Ratio 5 to 1) 4.75

Ask your dealer for them, and insist on getting "ALL-AMERICAN" or nothing. If none of your dealers handle the line, send order to us with dealer's name and address, we'll see that you are supplied promptly.

FREE Book of Hook-Ups. Gives over 25 diagrams of the latest Radio and Audio circuits. Send 2c stamp for postage.

RAULAND MFG. CO.
35 So. Dearborn St., Chicago, Ill.

Built on Honor

The Acid Test

Gently tap one terminal of Ambassador Phones on a cent, or your tongue, and a faint "click" will be heard.

(Other phones will not stand this test.)

Type A B	Prices
2000 Ohms	$5.00
3000 Ohms	5.50
4000 Ohms	7.00
5000 Ohms	8.00

Individuals may order by mail and we will gladly ship C. O. D.

Ambassador
RADIO-PHONES
The PHONES THAT STAND THE ACID TEST
Finest in the World at the Price

$1000 REWARD

to anyone showing proof of our refusing to stand back of our guarantee on Ambassador Phones.

Specifications

Adjustable (navy type) headbands, comfortable and strong, beautifully nickeled.

Case of heavy stamped aluminum.

Cap of finest hard rubber and unbreakable.

Coils wound with highest grade enameled copper wire.

Magnets of Chrome steel will retain their power for years.

5 foot cords—best grade tinsel.

Weight, 12 ounces. Shipping Weight, 1 lb.

Our Guarantee

If you are in any way dissatisfied with our product, return same within thirty days and your money will be refunded on request

Special Discounts to Dealers

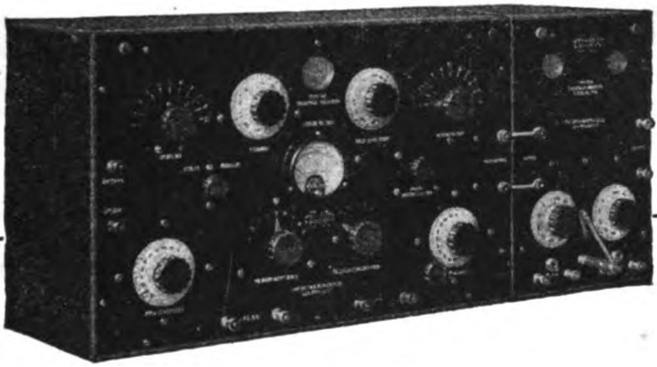
TOWER MANUFACTURING CO. - 114 Station St., Brookline, Mass.

KENNEDY

uses

KENNEDY EQUIPMENT

KENNEDY EQUIPMENT



Formica Panels and Insulation

THE COLLIN B. KENNEDY COMPANY uses Formica exclusively for its panels, tubes and other insulating parts in its entire line of Receiving Sets.

The handsome appearance of Formica, its high dielectric strength and wonderful uniformity meet the exacting Kennedy standards and have contributed to the creation of the splendid Kennedy reputation.

A list of the companies that use Formica Insulation reads almost like a directory of the leading independent radio manufacturers.

This patronage of men who know radio insulation establishes Formica's claim to leadership in its line.

DEALERS: Formica advertising and sales support is the most aggressive and effective in the industry. The Formica Insulation Company treats you right.

The Formica Insulation Company
4641 Spring Grove Avenue
Cincinnati, Ohio

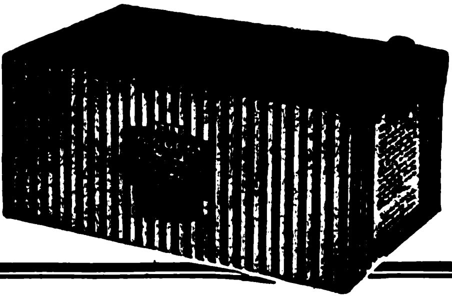
SALES OFFICES

50 Church St., New York, N. Y.
422 First Ave., Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Bldg., Toledo, Ohio

1210 Arch St., Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Bldg., San Francisco, Cal.
Whitney Central Bldg., New Orleans

414 Finance Bldg., Cleveland, Ohio
9 S. Clinton St., Chicago, Ill.
313 Title Bldg., Baltimore, Md.
47 King St., Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS



BURGESS
RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.

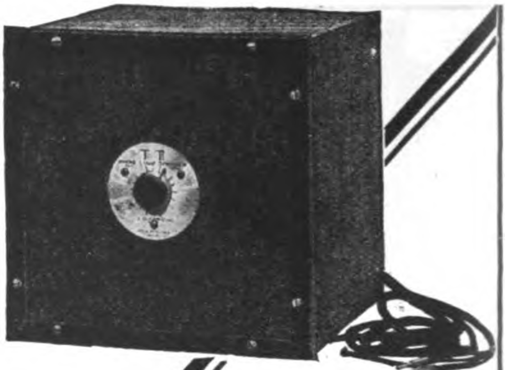
BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

BURGESS BATTERY COMPANY
Engineers Manufacturers
Dry Batteries
Flashlight Radio Ignition Telephone
General Sales Office:
Harris Trust Bldg., Chicago
Laboratories and Works:
Madison, Wisconsin
Branches:
New York Boston Washington St. Paul
Kansas City New Orleans

In Canada: BURGESS BATTERIES, Ltd.
Winnipeg Toronto Montreal

BURGESS
RADIO BATTERIES
"ASK ANY RADIO ENGINEER"



IT DOES WHAT YOU WANT IT TO DO!

BECAUSE of its unique amplification adjustment which allows you to get the utmost from your set, whether receiving distant stations or powerful local broadcasting.

DON'T CONFUSE THE TIMMONS TALKER with the ordinary horn type of loudspeakers—it is self-contained in a beautiful solid mahogany cabinet (approximately 10" x 10" x 9") and requires no extra batteries. It has no delicate mechanism to get out of order.

YOU WILL BE DELIGHTED with its rich, mellow tone and beautiful appearance. To own a TIMMONS TALKER is to achieve real radio refinement. It is sold by most worthwhile dealers; we invite your correspondence if not sold by your dealer.

DEALERS

TIMMONS **T**ALKER

We have a most attractive proposition that will appeal to both dealer and jobber.

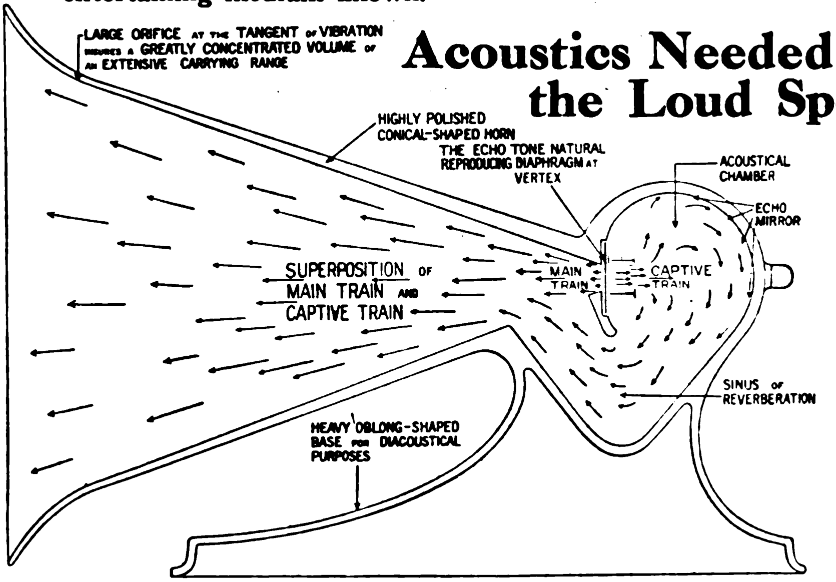
We will be glad to ship any dealer or jobber (with privilege of return) an instrument C. O. D. for inspection.

J. S. TIMMONS
337 E. Tulpehocken St.
PHILADELPHIA, Pa.

Echo-Tone Places Radio Among the Fine Arts!

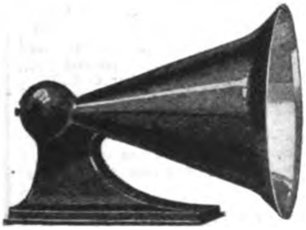
A standard long-distance receiving set equipped with an ECHO-TONE now is considered to be the latest musical instrument and the most diversified entertaining medium known.

Acoustics Needed to Perfect the Loud Speaker


LARGE ORIFICE AT THE TANGENT OF VIBRATION INSURES A GREATLY CONCENTRATED VOLUME OF AN EXTENSIVE CARRYING RANGE
HIGHLY POLISHED CONICAL-SHAPED HORN
THE ECHO TONE NATURAL REPRODUCING DIAPHRAGM AT VERTEX
ACOUSTICAL CHAMBER
ECHO MIRROR
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
MAIN TRAIN
CAPTIVE TRAIN
SINUS OF REVERBERATION
HEAVY OBLONG-SHAPED BASE FOR DIACOUSTICAL PURPOSES

Echo-Tone is more than a loud-speaker, it is an acoustical instrument. An instrument scientifically designed especially for Radio Telephony. It is heavy for diacoustical purposes, it has its own natural reproducing diaphragm of a secret composition which is non-periodic, and by adopting an acoustical chamber, an Echo-Mirror and a Sinus of Reverberation, it has applied Resonance to the Loud-Speaker.

PATENT PENDING



ECHO-TONE

A Value Which Marks A New Epoch

SPECIFICATIONS

Diameter of horn: 15 inches.
Length of instrument: 20 inches.
Base: 15 inches x 6 inches.
Over All Dimensions: 15 x 16 x 20 inches.
Weight: 15 lbs.
Material: Casted aluminum.
Finish: Mahogany grain.

Mechanism: Baldwin Type C Unit equipped with The Echo-Tone Natural Reproducing Diaphragm.

Cord: Black mercerized.

Increased Volume From Any Set. No Extra Battery Or Transformer Used. Operates On One Or Two Stages Of Audio With From 22½ to 135 B Battery Voltage On Plates.

The Workmanship—Material—Performance—and Price are Echo-Tone's Answer to The Public Cry for Better Quality Apparatus.

RETAIL PRICE $35.00

Did You Ever Hear Radio

with a volume, clarity and tone so natural that you would swear the artists were in the room, and with a carrying range so extensive you could hear it plainly thruout your home? Or, is this what you have been waiting for, before you bought a Radio Set? Well, at last, your wait is at an end; for that is what Echo-Tone has given to Radio—and to such an extent that head telephone sets are not even needed to tune in!

Demonstrated in your home on your own set

If there is no Echo-Tone dealer near you, send a check or money order for $35.00 direct to us. Upon receipt of the money, we will immediately express an Echo-Tone to you. Try it out on your own set. If it does not prove entirely satisfactory to yourself and family, replace it in its wooden box and give it to the expressman consigned to us. Simply mail us the express receipt, not even necessary to write us your reasons for returning it. As soon as we receive the receipt, we will refund your money, without even waiting until we receive the instrument. Remember, we pay express charges both ways, making it just as convenient as though you were buying in the same city.

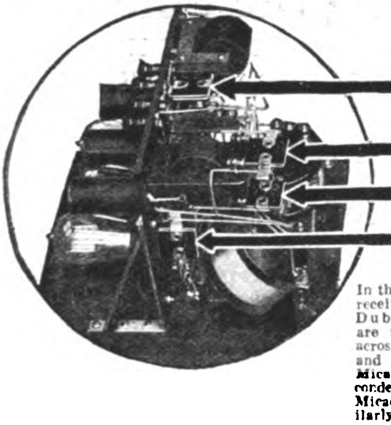
Qualified Dealers Wanted

Introducing ECHO-TONE, thruout the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has been allotted to your district.

You deal direct with us—no middle man.

WILLIAMS RADIO COMPANY

1438 WASHINGTON BLVD. WEST
DETROIT, MICH.



In this DeForest radio receiving set three Dubilier Micadons are used as a shunt across the transformers and one Dubilier Micadon as a grid-condenser. Dubilier Micadons are similarly used in other standard receiving sets.

Why Dubilier Micadons *are used in DeForest Sets*

PERFORMANCE (and therefore the reputation of a radio manufacturer) is so dependent on good condensers that in De Forest radio receiving sets and in others equally well known, Dubilier Micadons are the standard equipment.

Unless a radio receiver is fitted with Dubilier Micadons the broadcasting station is not heard at its best.

The list price of Dubilier Micadons varies from 35c to $1.50 each, depending on the capacity.

Send for descriptive circular.

DUBILIER CONDENSER AND
RADIO CORPORATION
48-50 West Fourth St., New York

BRANCH OFFICES

San Francisco, Cal., 709 Mission St.
Washington, D. C., Munsey Building
St. Louis, Mo., Syndicate Trust Bldg.
Chicago, Ill., 33 So. Clinton St.
Atlanta, Ga., Forsyth Building
Seattle, Wash., 1926 L. C. Smith Bldg.
Pittsburgh, Pa., 704 Granite Bldg.
Los Angeles, Cal., 329 Union League Bldg.
Huntington, W. Va., 1028 Fourth Avenue

Distributed in Canada, by Canadian General Electric Company, Ltd., Toronto

---

The BEST BATTERY *for* Dry Cell Tubes

Instantly Recharged

"Spare" electrodes exchangeable at your dealer's or direct from us at 40c each.

One 40c MAGNO electrode will operate one to three dry-cell tubes. Furthermore one MAGNO charge lasts several times longer than dry cells. Voltage always sufficient, assuring long-distance reception minus bothersome battery noises.

"Spare" electrodes never run down when not in use. Don't keep buying dry cells. Think of the money this battery will save you, giving at the same time ideal service.

Write today for descriptive folder!

STORAGE BATTERY MAGNO

Price Only $4.00

***Exchange Electrodes* 40c**

MAGNO
Storage Battery Corporation
Aeolian Bldg., New York

MU-RAD RECEIVERS
SUPREME

The New Star in the Radio World

EVERYDAY RECEPTION over distances that far outstrip the commonly accepted records — this (not baseless claims) is the evidence of MU-RAD superiority. The only set that can achieve such astonishing sensitivity, using a small loop aerial. Delightfully fine selectivity. With all this efficiency and completeness, utterly simple to operate. Each set guaranteed for 1000 miles reception.

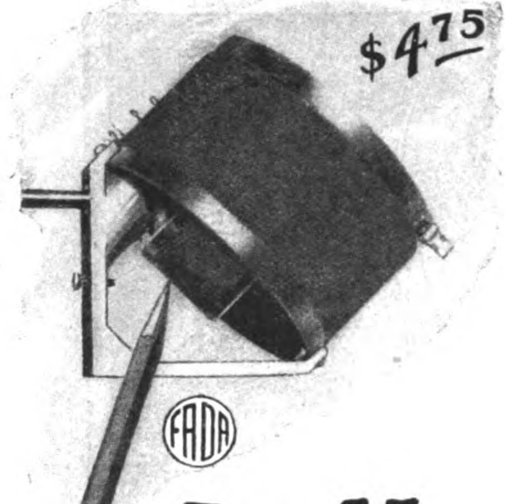
4300 MILES
on an indoor loop aerial

Four thousand, two hundred and seventy-eight miles away in Honolulu, the Royal Hawaiian Orchestra plays for delighted listeners in St. Louis, U.S.A., through their MU-RAD Receiving Set. An example of MU-RAD supremacy.

Write For Literature.

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY



Double As Good

The scientifically correct design of the *FADA VARIO-COUPLER* enables a very gradual variation of coupling over 180 degrees. Ordinary couplers give only a 90 degree variation, and hence the Fada 180 degree type has double the efficiency.

Its simplicity and high efficiency in signal selection by vernier control of coupling has given the Fada 180 degree coupler universal demand.

Vernier Rheostats

The nationally famous Fada Rheostat with a new Vernier attachment.

No. 150-A Fada Vernier Rheostat............ $1.25

Potentiometers

Mechanically perfect spacing and winding of the resistance wire resulting in smoother adjustment.

No. 152-A Potentiometer (200 ohm)........ $1.00
No. 154-A Potentiometer (400 ohm)........ 1.00

Fada ingenuity—manufacturing economy—value—guarantee—and low prices, are responsible for the popularity of Fada radio parts.

The Fada Handbook gives facts about the use of each radio part, and will be of aid to you in your radio construction work. Send 10c for your copy.

F. A. D. ANDREA
1581-D Jerome Ave. New York City

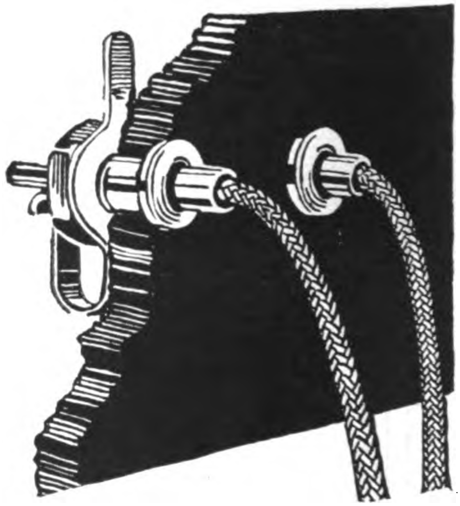
Fada Equipment

Try Them Today!

Quick Connecting UNION-RADIO PHONE TIP JACKS

(*Pat. Applied For*)

25c A PAIR



These Phone Tip Jacks are now recognized as the greatest small Radio Electrical Device of the age. They replace unsatisfactory binding posts. Easy adaptation, quick operation, positive contact. Attractive in appearance. Soldering lug incorporated, but use optional.

Accommodate any standard round phone tip and several sizes of bare wire. Ideal for W D 11 connections and coil mountings. These Union Radio Jacks **save buying expensive telephone plugs and jacks.** Made to live up to Union Radio Standard of Quality. Only 25c a pair.

FOR ASSURED RESULTS

you should "try out" Union Radio Tip Jacks, Variable Condensers, Rheostats, Vacuum Tube Sockets, Condensite Dials, Complete Receiving Sets and Two Step Amplifiers.

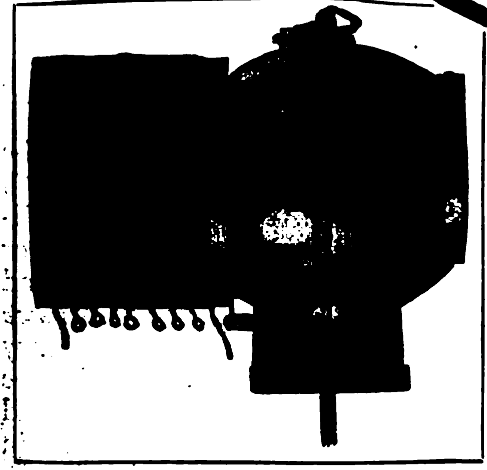
Union Radio Apparatus and Accessories are sold by most good dealers. If you can't obtain them from your local store mail your order to us. Write for a copy of our Catalogue A, Radio Apparatus.

Wholesalers and Retailers:

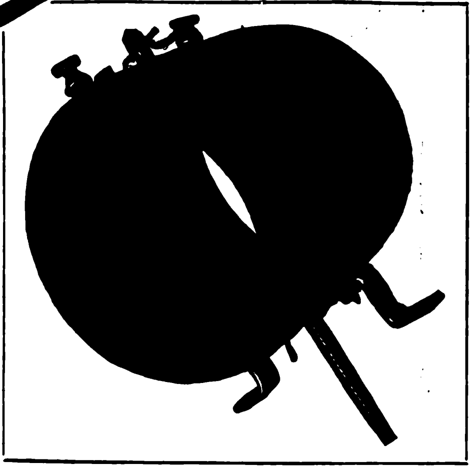
Write for our liberal proposition. Dealers' Catalogue A and Price List, also samples sent on request.

UNION-RADIO-CORPORATION
200-MT. PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE—116-WEST-32ND-STREET

SE-AR-DE



Catalogue No. 165 . . . $13.00



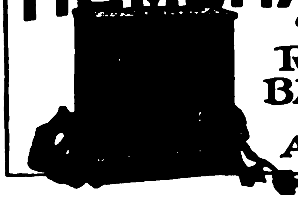
Catalogue No. 166 . . . $5.50

KNOCK DOWN SET TYPE AD $28.00

Range 1000 Miles. Fitted for Std. or WD 11 Tube

R. MITCHELL & CO.

255 ATLANTIC AVE. BOSTON, MASS.



HOMCHARGE *your* **RADIO BATTERY** *for* **A NICKEL**

Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery over night for a nickel without removing it from your living room. No muss—no trouble—no dirt—requires no watching.

After the concert connect to any lamp socket, snap the clips on your battery and "turn in." While you sleep the HOMCHARGER is silently charging your battery, the charging rate being governed automatically. In the morning it is fully charged. No OTHER battery charger can boast of such quick and economical performance.

The HOMCHARGER is the only battery charger combining all of these NECESSARY HOMCHARGING features — SELF-POLARIZING — FIVE to EIGHT AMPERE charging rate — UNDERWRITERS' APPROVAL—beautifully finished in mahogany and old gold—UNQUALIFIEDLY GUARANTEED. OVER 90,000 NOW IN USE.

Sold complete with ammeter, etc., by all good radio and electrical dealers for $18.50. ($25.00 IN CANADA.)

See the RADIO HOMCHARGER DE LUXE at your dealer's or write direct for our FREE circular showing why the HOMCHARGER is the BEST battery charger at any price.

MOTORISTS

The HOMCHARGER will also charge your AUTO Battery.

The Automatic Electrical Devices Co.
132 West Third St., CINCINNATI, OHIO

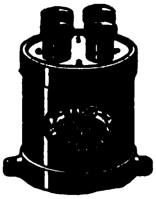
Largest Manufacturers of Vibrating Rectifiers in the World

The New R T-8 Radio Frequency Transformers

on the market March 1st, 1923, are specially designed by the *Radio Service Laboratories* for maximum efficiency when used with any low filament current consumption and low voltage tubes on the market.

For Audio Frequency the new RT-A2 will give you 100% Tone Quality and High Amplification without distortion. For best results on both tone and distance, use *Radio Service Laboratories* Radio Frequency R T-8 (for all stages) in the black case, retail price $6.00 and Audio Frequency RT-A2 in brown case, retail price $6.50. For sale at all reliable electrical or Radio Stores.

If your dealer cannot supply you, order direct. Order by type number, accept no substitute, and remember that all *Radio Service Laboratories* Transformers are individually triple tested and unconditionally guaranteed.



Send ten cents for new booklet on Radio Frequency with schematic diagrams—a most valuable and helpful publication for the radio amateur and expert.

Rasla Sales Corporation
National Distributor
Dept. P 10 East 43rd Street
New York City

Brandes

ARE you getting long distance radio stations—are you catching clear and distinct the faintest signals that mark the extreme range of a good receiving set? A Brandes *Matched Tone* Radio Headset will make the faint signals understandable. The two receivers are perfect sound-mates—they are matched in tone to improve the clearness of the message. Brandes *Matched Tone* Headsets are guaranteed to get the best results obtainable from any set.

¶ Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

District Offices:

76 Pearl Street, Boston, Mass.
709 Mission Street, San Francisco, Cal.
Munsey Building, Washington, D. C.
802 Forsyth Building, Atlanta, Ga.
33 South Clinton Street, Chicago, Ill.
1220 Nicollet Avenue, Minneapolis, Minn.
704 Granite Building, Pittsburgh, Pa.
1028 Fourth Avenue, Huntington, W. Va.

Distributors in Australia and New Zealand:
International Electric Co., Wellington, N. Z.

Made in Canada and England by
Canadian Brandes, Limited, Toronto and London
Distributed in Canada by Perkins Electric, Limited
Toronto — MONTREAL — Winnipeg

C. Brandes, INC. - 237 Lafayette St. N.Y.C.

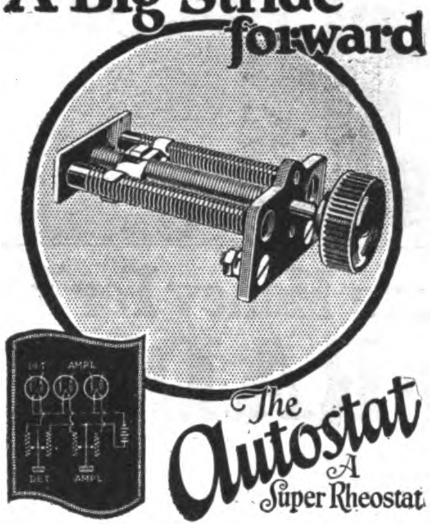
Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

Dept. P.R.

A Big Stride forward



The Autostat

A Super Rheostat

Can be used with 6-Volt or WD11 Detector Tubes, two Amplifying Bulbs, or one 5-Watt Power Tube.

THE AUTOSTAT presents an entirely new principle in filament rheostat construction and radio takes another BIG step forward.

No longer is it necessary to turn a "hair's breadth" to tune in that elusive station, for with the AUTOSTAT you can give the knob a substantial turn and get a superfine adjustment. No other rheostat to date possesses the necessary "fineness" of adjustment to eliminate interference and "tube howls" under all conditions. But the AUTOSTAT, with its micrometer adjustment, will positively give these much-sought-for results.

How It Works

Two parallel mounted resistance tubes are connected in series by a "micrometer-operated" slider—the length of wire in circuit depending upon the location of this movable slider. Forty turns of the AUTOSTAT knob are required to complete the variation from minimum to maximum resistance—against one-half to three turns on others.

This exclusive patented construction means:

1. **One full turn of AUTOSTAT knob produces finer tuning than a "hair's-breadth" turn on any other.**
2. **Economical—only two AUTOSTATS required for a three-bulb set.**
3. **Greatly increased receiving range and clearness of signals.**
4. **A uniform change in resistance with each turn of the AUTOSTAT knob.**
5. **Indestructible wire-wound fireproof lava resistance element.**
6. **Unqualifiedly guaranteed.**

***Popularly priced,* $1.35**

Dealers

See your jobber or write direct for Radio's most attractive Rheostat proposition.

The AUTOMATIC ELECTRICAL DEVICES CO.
132 W. Third St., Cincinnati, Ohio

Builders of Precision Rheostats Since 1914

More Money For You *in* RADIO

THE amazing expansion of Radio has opened up thousands of wonderful new positions on land and sea. Big salaries, fascinating, easy work, short hours, and a wonderful future are offered to ambitious men who get into Radio now.

Take advantage of these wonderful opportunities to step into a big paying position in this great new field. Radio offers you an opportunity to travel and see the world, with all expenses paid, and a fine salary besides. Or you can stay at home and work up to a position paying up to $10,000 a year. One of our recent graduates secured a position one week after graduating, paying a salary of $300 per month.

Easy to Learn Radio at Home

Hundreds of men are already earning handsome incomes in this wonder science. If you want to get into a profession where opportunities are unlimited make Radio your career—become a Certified Radio-trician.

Thousands of Certified Radio-tricians are wanted to design Radio sets; to make new Radio improvements; to manufacture Radio equipment and to install it; to maintain and operate great Broadcasting stations and home Radio sets; to repair and sell Radio apparatus; to go into business for themselves; to operate aboard ship and at land stations.

You can easily and quickly qualify in your spare time at home through the help of the National Radio Institute. Prominent Radio experts will help you. Four wonderful instruments are furnished free, making the work thoroughly practical. The same plan that has already helped hundreds of our graduates to real success and real money in Radio is open to you.

Special Opportunity Now Open

The urgent need for radio experts and the calls which come to us for our students prompt us to make a special offer open to new students for a limited time. Through this special offer your enrollment will be accepted at a special rate, and you will receive, without extra cost, our new course in Wireless Telephony.

Big Book Free

No other field today offers such great opportunities as Radio. Take your choice of the many wonderful openings everywhere. Prepare now to step into the most interesting and best paid profession today. Read about the opportunities open now—the different kinds of work—the salaries paid. Write today for the free 44-page book that tells how America's first and biggest Radio school can make you a Certified Radio-trician in your spare time. Mail the coupon or write a letter NOW.

NATIONAL RADIO INSTITUTE, 1345 Pennsylvania Ave., N. W., Dept. 32-D, WASHINGTON, D. C.

National Radio Institute, Dept. 32-D
1345 Pennsylvania Ave., N. W.
Washington, D. C.

Send me your free book "How to Learn Radio at Home" with full particulars about the opportunities in Radio and how you will quickly train me in my spare time at home to become a certified Radio-trician. Also tell me how your free employment service will help me to a position and particulars of your special short time offer.

Name .... Age..........
Street ....
City .... State..............

Compare These Prices

WHY PAY MORE WHEN YOU CAN GET ROCK BOTTOM PRICES FROM US

Just glance over our list and send us your Money Order. Twenty-four hours after receiving your order it is on its way to you.

LIST PRICE		OUR PRICE
$ 5.00	Radiotrons UV-200	$ 4.25
6.50	" UV-201	5.75
16.00	Baldwin Phones, type C	12.00
7.75	" Units Loud Speakers	6.00
8.00	Federal 2200 Ohm Phones	6.00
8.00	Brandes Superior "	7.00
5.00	Acme Transformers	4.25
1.00	Double Jacks	.60
.70	Single "	.50
2.50	Bull-Dog Plugs	1.25
	Contact Points, per doz	.15
	Switch Levers, 1½" radius	.25
45.00	Magnavox	38.00
1.50	100 ft. Stranded Aerial Wire	.60
.50	Aerial Insulators	.20
1.00	100 ft. Solid Aerial Wire	.40
75.00	Paragon RA-10 Set	68.00
25.00	90 ampere guaranteed Storage Battery	18.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.75
1.00	Vacuum Tube Sockets	.65
18.50	Homchargers	15.50
3.50	B. Batteries volt meters 0-50 V...	2.75
55.00	Western Electric New Style Loud Speakers	42.75
.75	Rheostats	.60
3.00	B. Batteries	2.25
2.50	" "	2.00
1.75	" "	1.10
1.50	Dials	.75
1.00	"	.40
2.75	De Forest Detectors	1.95
.75	Sockets	.60
4.50	Thordarson Transformers	3.75
2.00	Potentiometers	1.25
	½ Megohm Grid Leaks	.00
	1½ " " "	.65
1.00	Grid Leak Holders	.65
1.00	Double Phone Cords	.00
.50	Single " "	.35
	Duplex Phone Adapters, fits Edison, Victor or Columbia	1.75
	Genuine Bakelite Panels, per sq. in.	.02
	Spaghetti, per ft.	.09
12.00	Genuine Western Electric Signal Corps V.T.-2-Tubes	9.00
112.00	De Forest type. Honeycomb Set, special Mahogany Cabinet	65.00
3.00	Racony Electric Light Aerial	2.00
35.00	Audmiax Loud Speakers	18.50
6.50	Turney 3,000 Ohm Phones	4.25
4.50	Diamond 2,000 Ohm Phones	3.75
5.00	Fischer Variometers	3.75
6.00	" "	4.75
5.00	" VarioCouplers	3.75
6.00	" "	4.75
8.00	Atwater-Kent Variometers	7.00
8.00	" " VarioCouplers	7.00
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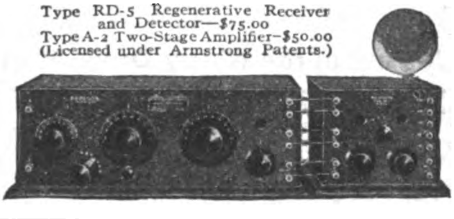

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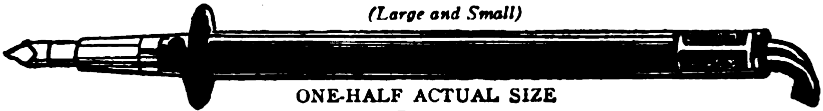

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SEND 25c in coin or money order for our big 256-page combined radio catalog and text book. For radio information and hook-ups it is worth many times the retainer asked.

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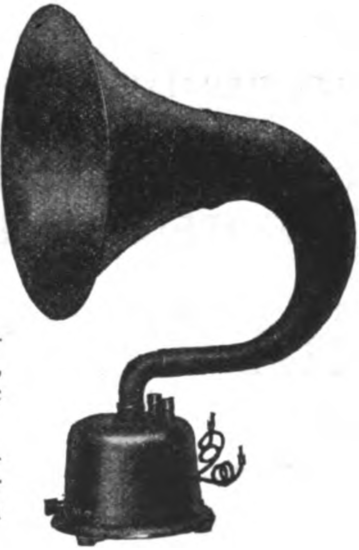
BRISTOL AUDIOPHONE JR.

Loud Speaker



For Radio-Phone Reception the AUDIOPHONE JR. is a strictly high-grade instrument, built to Bristol standard and backed by the Bristol reputation of 33 years.

The Audiophone Jr. is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set.

It is a true sound reproducer, bringing to home or public hall the distinctive qualities of the original performance. Characterized by its round, full, mellow tones—its ample volume—and freedom from blurring, mechanical distortion, and metallic effect. It has made radio a real source of restful, refreshing entertainment.............................. **Price, $22.50**

The Audiophone Jr. can be used with any two or three stage power amplifying outfits. Where two stage amplification does not give the desired volume, the range of the Audiophone will be made ample by the addition of a Bristol One Stage Power Amplifier .... **Price, $25.00**

Bulletin 3006—L on request—Demonstrations arranged for

THE BRISTOL COMPANY
Waterbury, Conn.

casually that we amateurs would be one day chatting with each other *via* transatlantic amateur radio. He said that he thought it would be possible and that he hoped the French Government would permit amateur transmission, which up until this time it had not. All this has happened in the short space of three years; in a letter received just a few days ago from Deloy, he says:

"Well, OM, this is a great day for me and I know you will be glad too, as the first half of your prediction of three years ago has come true! Now for the other half! I must get through to you."

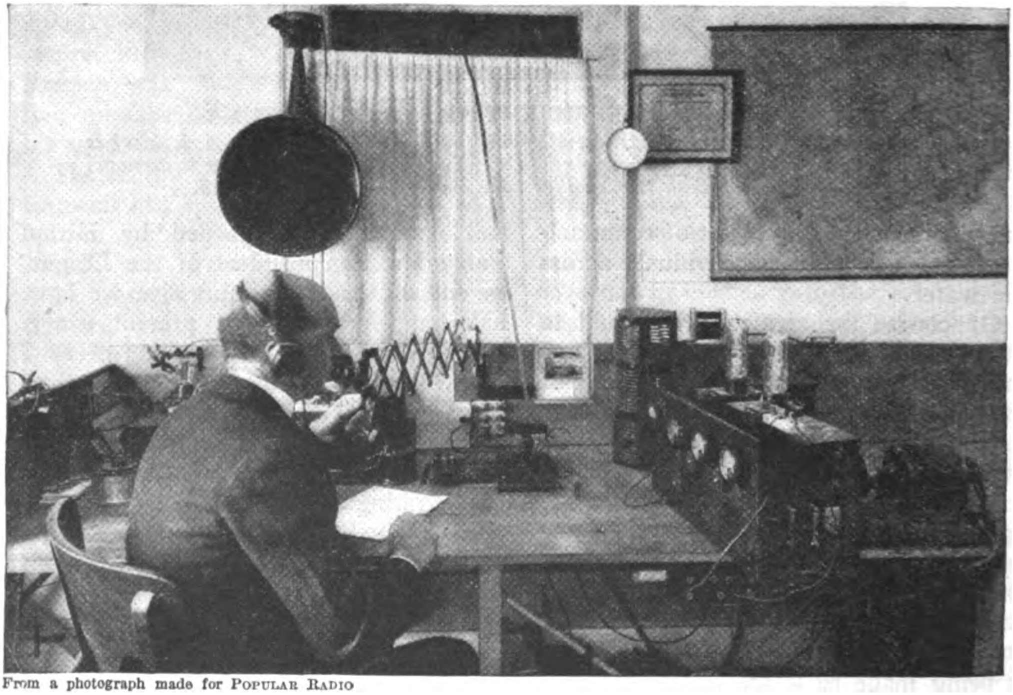
Deloy's station did get through and was copied for an hour on one night of the tests by C. A. Service, assistant secretary of the League, who also was with us at Washington.

But what is even more surprising to me is that not only did well-equipped, powerful amateur stations that qualified in the preliminary tests "get across," but also a large number of crude home-made sets, some of them with no more power than it would take to heat the filament on a 50-watt electric lamp. Probably a vast majority of our most successful stations during the transatlantic tests represented a collection of home-made parts, carefully tuned for greatest efficiency.

During the preliminary tests, Mr. Maxim often referred to his own set (1AW) as a "mere toy," saying to me:

"Schnell, we need something with a bigger bite, this is only a little nibble."

He meant particularly the little transmitter consisting of four 5-watt tubes with which we were able to squeeze about two amperes into the "toy antenna" consisting of a four-wire cage with wires spaced about one and one-half inches



From a photograph made for POPULAR RADIO

A YANKEE AMATEUR WHOSE SIGNALS ARE HEARD BY HALF THE GLOBE

Here is J. O. Smith, at the helm of his record-breaking station at Valley Stream, Long Island. "J. O." has tried out about every kind of circuit and all of the various types of transmitting tubes. But it does not seem to make much difference what he uses he is always breaking records.

From a photograph made for POPULAR RADIO

HE TALKED WITH EUROPEAN AMATEURS
FIVE CONSECUTIVE NIGHTS

Floyd L. Vanderpool and his exceptionally complete radio station 1BEP, at Litchfield, Connecticut. The powerful C.W. transmitter at the left was heard on five evenings in succession by both English and French amateurs.

apart. Practically speaking it was a large single wire antenna and nothing more, 80 feet high at one end and about twelve feet at the near end, and when I reported to him that 1AW had been heard by amateurs in France, he exclaimed:

"My ideas and training on radio will need smoothing out and some explanation for this low-power business of transatlantic communication will be forthcoming."

Station 1AW was one of the last to give up the old spark, but with the coming of broadcast listening and for fear of unjust complaints and criticism because of spark interference, Mr. Maxim changed over to C.W. in time to avoid any such happenings, and the good showing was the cause of his remark that the spark at 1AW will be heard no more.

There is no more enthusiastic amateur than Herbert Hoover, Jr., whose station (3ZH) at Washington, D. C., was heard by amateurs in Switzerland on December 21st, the last day of sending by American stations. The first thing which he did on his return from college for the holidays was to rig up a special radio set at the Bureau of Standards in order to take part in the transatlantic tests. In a letter to me he thus described his station, which was successful in "getting over."

"It consisted of four 'Mullard' tubes, with an input of about 150 watts each. As they got warm over 1,000 watts input, the station would be rated at 500- or 600-watts output. High-voltage dry batteries were used for the plate supply and at 1,500 volts they put six amperes into the antenna. I erected both the antenna and set just for these tests through the courtesy of Dr. Stratton, who will be overjoyed at the good news.

"The antenna is a 50-foot cage, 2 feet in diameter, strung from the Navy mast to the Electrical building. It is about 125 feet high and the lead-in is partly cage (6 inches) and partly ribbon. As the high-voltage battery leads extended all the way through the building, they in themselves, acted as a very good ground. When using the reversed feed-back circuit, I tuned the counterpoise (a semi-circular pan of 30-foot radius) to the rest of the set with a separate inductance, and used no other ground connection at all.

"I tested during the 'free-for-all' that evening and afterward worked 9BHX, but DX work was very hard, for the wave is 240 (I can't get lower on account of battery leads) and very sharp. The receiver is a D.S. amplifier with an external heterodyne, and it has a 'CR' skinned a mile! NOF is going, too."

It is not without the bounds of possibility to pre-suppose that an amateur "relay around the world" is not far off. Were there radio amateurs in Australia, Japan, China and the Philippines, this would be but a matter of making the necessary arrangements and conducting the preliminary tests. Preliminary tests are necessary because the weak points are thereby located and readily reinforced. As an example of what is possible, a message may be started from London, England, picked up on the Atlantic Coast of the United States, relayed to the Pacific Coast, thence to the Hawaiian Islands, to Japan, Australia and the Philippines, thence perhaps through one or two European countries, back into London.

With our successful "radio" acquisition of the Hawaiian Islands and Porto Rico during the last year, there is every reason to believe that we may connect up with countries in the Southern Hemisphere, especially South America and South Africa.

Who would dare to be bold enough to say?

From a photograph made for POPULAR RADIO

A YEAR-OLD STATION THAT HAS BEEN LOGGED IN SIX COUNTRIES

The amateur radio station 3BLF at Richmond, Virginia, is owned and operated by the youthful C. R. Hofmann and W. R. Deavers. Its C.W. signals have been logged all over the United States as well as in Canada, Hawaii, Cuba, France and England.

WHAT READERS ASK

This department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask The Technical Editor.

The flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our *subscription list*. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.

Question: I have read the article on the DX regenerative receiver in the January issue and would like to know if this circuit could be simplified so that only one or two controls need be used for tuning. I wish to use one tube only (for detector). Will you kindly furnish me such a diagram?

A. L. Williams

Answer: A simplified modification of the DX circuit is shown in Figure 1. Coils A and B are wound on a 3½-inch tube with a separa-

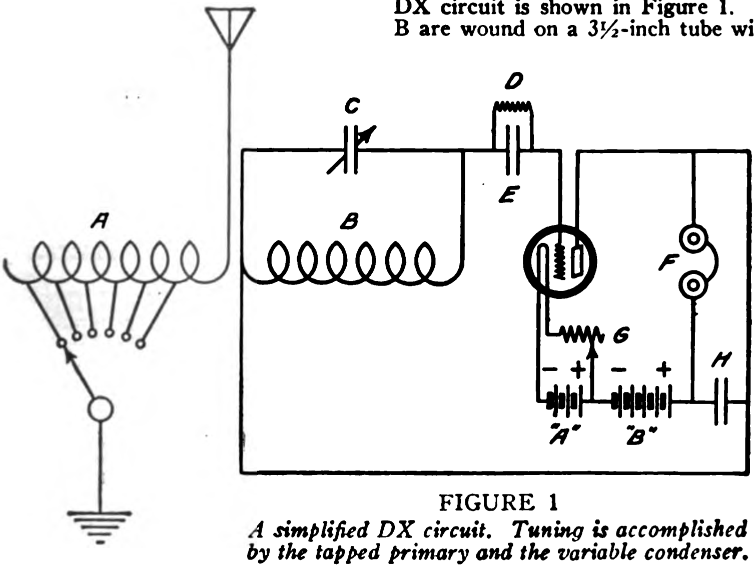
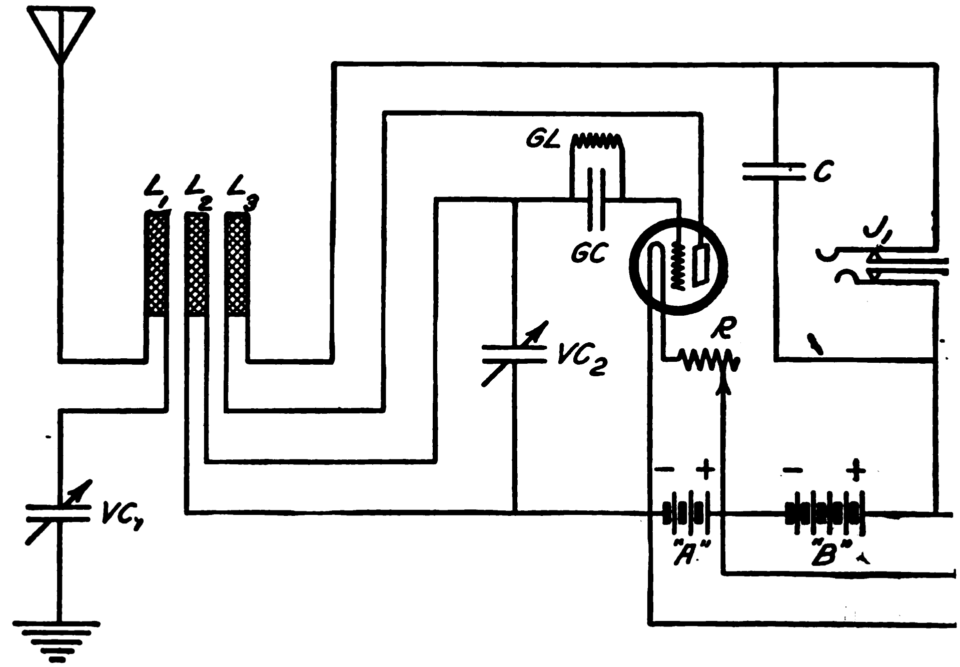


FIGURE 1

A simplified DX circuit. Tuning is accomplished by the tapped primary and the variable condenser.



tion between them of ½ inch. The primary coil A consists of 30 turns of No. 18 S.C.C. copper wire tapped every five turns. The secondary coil B consists of 65 turns of the same wire. The condenser C is a variable .0005 mfd. The grid leak D is 1 or 2 megohms; the grid condenser E is of .00025 mfd. capacity; the rheostat G is approximately 5 ohms; the fixed condenser H is a telephone condenser, .001 mfd.

The antenna tuning is accomplished by means of the taps on coil A. Secondary tuning is done with condenser C. Regeneration is controlled with rheostat G, which should have a vernier attachment. This circuit will be found exceptionally selective and easy to tune.

* * *

Question: Will you kindly give me a hook-up showing how to add two stages of audio frequency amplification to the honeycomb circuit shown in Figure 1 on page 59 of the May issue of Popular Radio?

Wilfred Burgess

Answer: The circuit is shown in Figure 2. The two jacks J1 and J2 are double circuit jacks, and J3 is a single circuit jack. The transformers AFT are audio frequency transformers. This circuit will enable you to use a loudspeaker.

* * *

Question: In one of your diagrams in answer to a question, you specify Radiotron UV-200 tubes for detection and UV-201 tubes for amplification. Out on this coast we find the Cunningham C-300 and C-301 sold more in the radio stores. Is there any preference between these two types? As far as I can see they are constructed exactly alike.

Francis Stern

Answer: Both of these two makes are good. The UV-200 and C-300 are soft tubes and are used as detectors, and the C-301 and UV-201 are hard tubes and are used as either detectors or amplifiers.

* * *

Question: What kind of wire is most suitable for a receiving antenna?

Harold Jenkins

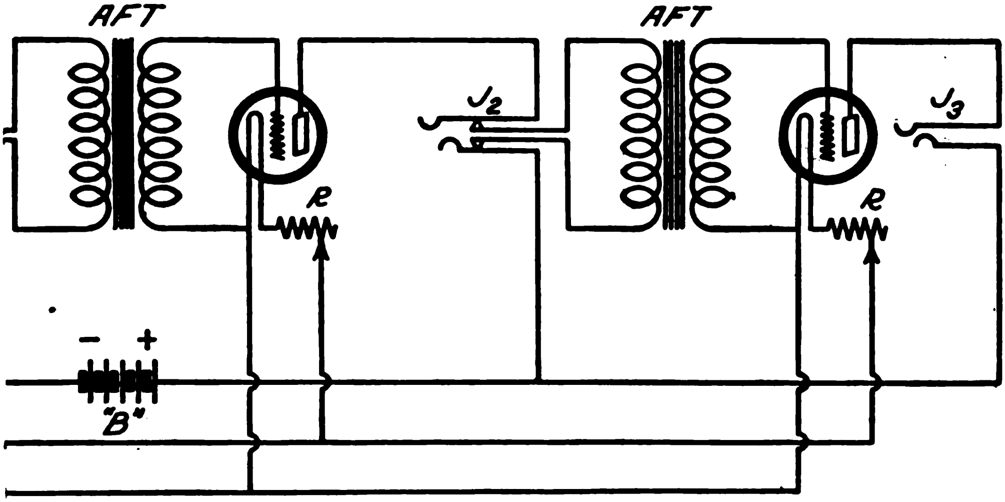
Answer: Seven-strand copper wire is the wire that is most generally used for the antenna. It is usually No. 12 or 14 and is kept in stock by most radio dealers.

* * *

Question: Please give me a diagram for a small radiophone transmitter that uses a Radiotron amplifier tube. I want the simplest hook-up that works. This will be my first transmitting set and I want to get familiar with a small one to start with. I want to work the set on

FIGURE 2

A three-coil honeycomb set with two stages of amplification that gives loud and clear signals on a loudspeaker.



a bank of "B" batteries. If this is possible please let me know what voltage batteries to use on the plate.

HOWARD V. BROOKS

ANSWER: We have drawn the circuit for you in Figure 3. The two coils P and S have 60 turns of wire wound on each of them. Coil P is wound on a 4-inch tube and coil S is wound on a tube slightly smaller so that it may be slipped inside coil P. The variable condenser VC should be of .001 mfd. capacity. It is advisable to tap the two coils at every other turn and make adjustable connection to them, for tuning, by means of clips. The variable condenser will be valuable in getting the set to oscillate properly. A voltage of approximately 100 to 125 volts should be used on the plate of the tube, but voltage less than this may be used, with, of course, a corresponding decrease in distance range. The microphone transmitter is connected to a loop consisting of a single turn of insulated wire wrapped around coil P. This, by absorption, causes the output of the set to be modulated at voice frequencies, when the microphone is spoken into. A transmitting license is required.

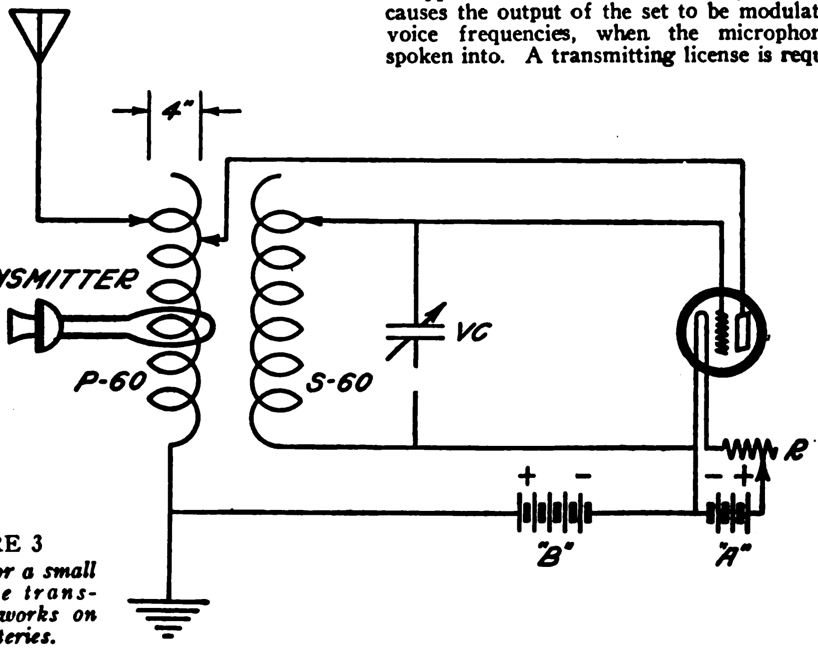


FIGURE 3

A hook-up for a small radiophone transmitter that works on "B" batteries.

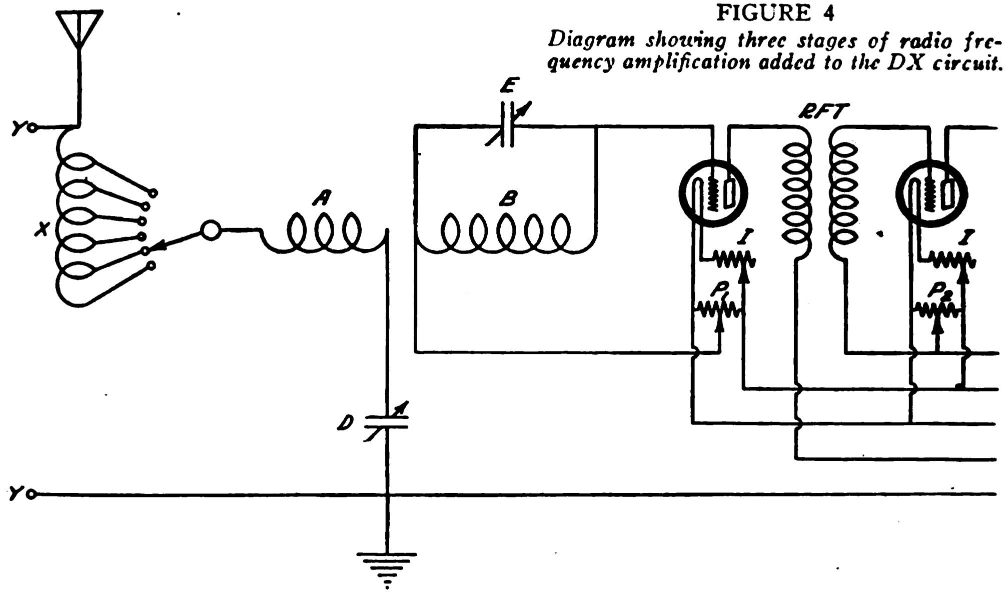


FIGURE 4
Diagram showing three stages of radio frequency amplification added to the DX circuit.

QUESTION: I have built the DX regenerative receiver described in your January number.

I have not been able to hear the other coast as yet, but I believe that if I added a few stages of radio frequency amplification to it, I could. Sharpness of tuning is its best quality. Would it be possible to add radio frequency and still retain the fine tuning qualities? If so, please send me the hook-up.

R. K. BENTMAN

ANSWER: The circuit diagram in Figure 4 shows how to add three stages of radio frequency amplification to the DX receiver. The variometer has been eliminated and a loading coil has been added. The two binding posts YY are for connection to a loop antenna if used. The potentiometers P1, and P2 are to control the grid circuits of the radio frequency tubes; they may also be used to control oscillation so that the circuit will receive C.W. The three radio frequency amplifying transformers, RFT, must be of a reliable make and have a wavelength range that will include that of broadcasting, as your query indicates that is the phase of receiving that interests you most. The other designations on the diagram refer to the same parts they did in the article in the January issue of POPULAR RADIO.

* * *

QUESTION: What is the normal distance range of the different types of radio receivers? I would like to know this roughly, so that I will be able to pick out a type of set that will suit my purpose.

ARTHUR C. STRANG

ANSWER: If you will refer to the article on page 24 in the January issue of POPULAR RADIO you will find data that will answer your inquiry in much greater detail than we could do in this space. The article contains data on this subject which should prove invaluable to the novice in selecting his set. There are two charts that will show you, at a glance, the type of receiver that will be best for you to use.

* * *

QUESTION: How many turns of wire should be wound on the rotor and stator of a variometer for use in the plate circuit of a regenerative receiver? I want to make one myself and am going to copy the design of one of the wooden variometers now on the market.

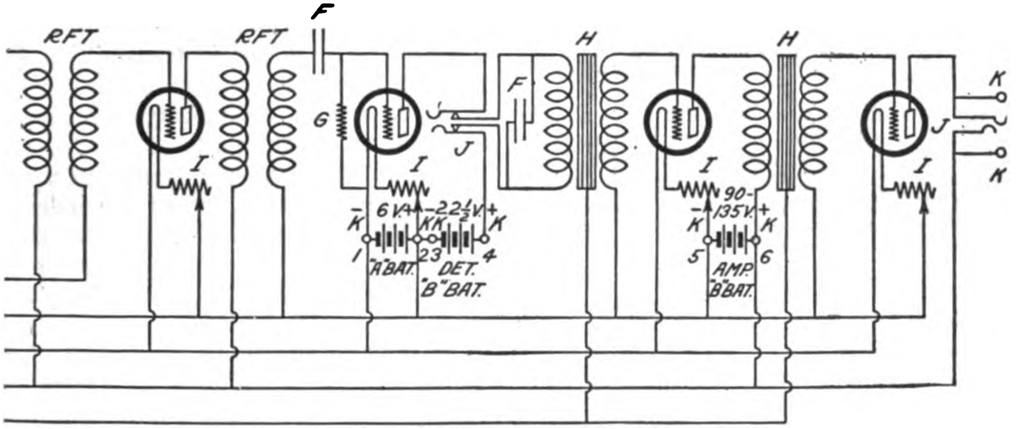
ROBT. M. ASHTON

ANSWER: If you make the variometer stator and rotor forms of approximately the same size as the most commonly used variometers you may use 40 turns on the stator and 50 turns on the rotor with good results. Use as little shellac as possible on the windings.

* * *

QUESTION—Can a variometer be used as a variocoupler?

L. E. T.



Answer: Yes. If the stator winding is detached from the rotor winding it can be used as the primary coil, with a variable condenser in series with the antenna circuit for tuning. The rotor winding may then be used as the secondary, with another variable condenser connected in shunt to it for tuning the secondary circuit. Or, in the single circuit regenerative hook-up, the rotor may be used as a tickler, as shown in Figure 3, page 223 of the July issue of Popular Radio.

* * *

Question: Will you kindly give me a circuit for a C.W. transmitter using one 5-watt tube, for telegraphy? I should like a circuit that will be simple to construct and yet efficient. I have heard a great deal of the "British aircraft circuit" and would like to use it if you think it would serve my purpose.

A. R. Woodworth

Answer: The circuit shown in Figure 5 will be suitable for your use, and it is easy to operate. The plate coil L1 consists of 40 turns of No. 12 D.C.C. copper wire wound on a tube four inches in diameter. The grid coil L2 should be wound on a tube which fits inside the plate coil L1, and should consist of about 10 turns of the same sized wire. This coil is shunted by a variable condenser, but if the coil is tapped the condenser may be eliminated. The condenser C which is connected across the high voltage terminals of the transformer may be between .001 and .005 mfd. capacity. The same transformer is used for lighting the filament. The hotwire ammeter is used to measure the antenna current. A milliameter, 0 to 100 milliampere scale, may be inserted in the plate circuit to measure the plate current if desired.

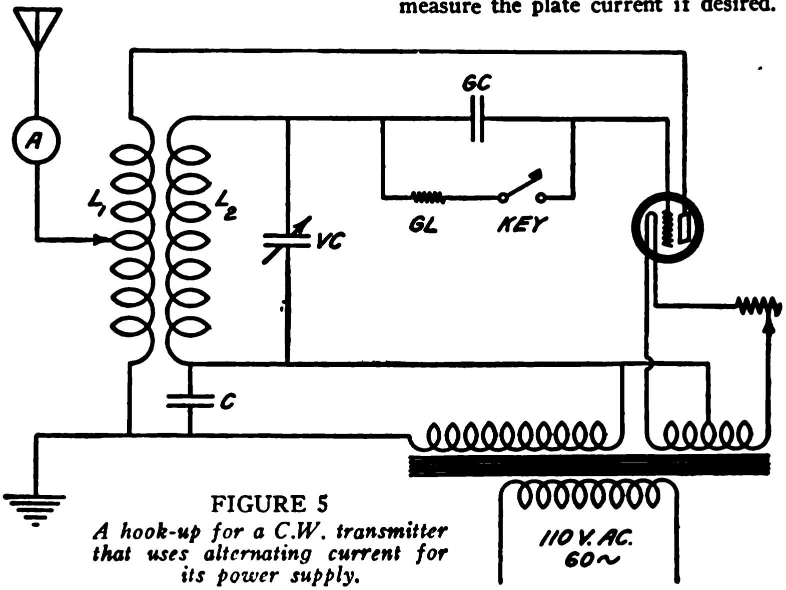


FIGURE 5

A hook-up for a C.W. transmitter that uses alternating current for its power supply.

QUESTION: Are paper grid condensers as good as mica grid condensers?

DONALD DIETZ

ANSWER: Paper condensers are not as reliable as the mica dielectric type because the capacity of the paper type is liable to vary with temperature and with pressure. Try this: use a paper grid condenser and tune in a signal. Then pinch the condenser between the fingers and the signals will tune in and out.

* * *

QUESTION: What is the greatest number of stages of audio frequency amplification that can be used with clear efficient reception?

THOMAS McCOOMBS

ANSWER: With two stages of audio frequency working efficiently, getting the maximum out of the vacuum tubes by means of the correct circuit, the correct transformers (transformers with the proper input and output impedances) and the best tubes, the signal strength will be as loud as with numerous stages, using instruments and tubes that *do not* match up properly. It is our opinion that two stages of audio frequency amplification constitute the greatest number of stages that should be used. There are many instances where three stages have been used with good results, but in most of these cases the amplification obtained in each stage has not been at a maximum. When more than two stages are employed with maximum amplification in each stage, there are usually many extraneous noises present that tend to interfere with and distort the received signals. Even with only two stages of amplification attached to a regenerative receiver the distortion, caused by regeneration, is often noticeable.

QUESTION: An amateur friend of mine recently interested me in transmitting (I was a broadcast listener up to this time); he made me a transmitting inductance and told me all the parts to buy for an A.C.C.W. vacuum tube transmitter. I am sending you a sketch of the inductance. My friend told me at the time that one coil was for the antenna circuit, one for the grid circuit and one for the plate circuit, and that the last two coils were to be shunted by variable condensers for tuning. He also made me a diagram to connect up the set, which I have unfortunately mislaid. I cannot get in touch with him and am impatient to get it hooked up and working so that I will be a *regular* amateur. Will you kindly help me out with a circuit that will show how to connect the power transformer for one Cunningham 5-watt transmitting tube? I have already learned the code and obtained a license.

ROBERT V. ASHCROFT

ANSWER: You will find the circuit you need in Figure 6. You will need another condenser C which should be about .002 mfd. capacity, and a grid leak 8,000 to 10,000 ohms. The key is inserted in series with the grid leak, for telegraphy. You will also need an antenna-current meter which should have a full scale deflection up to about 2 amperes.

You will get better results with this circuit if you use a counterpoise instead of a ground.

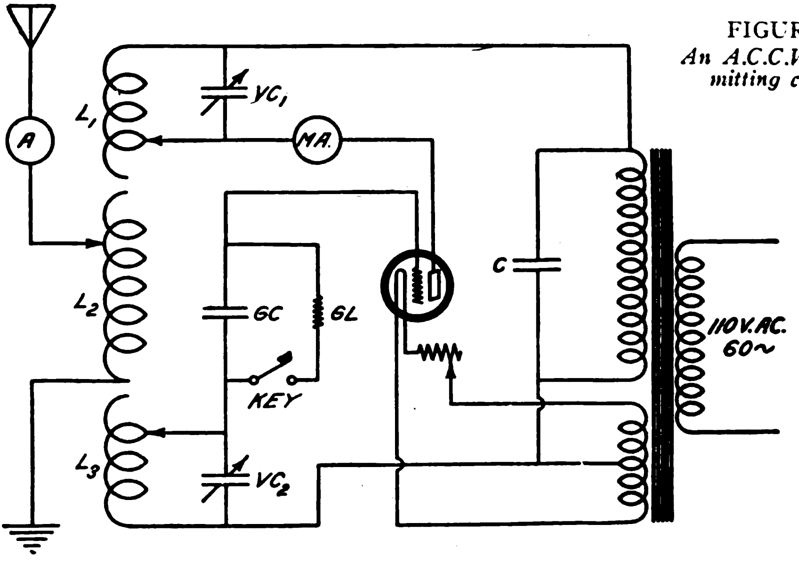


FIGURE 6

An A.C.C.W. transmitting circuit.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Will the Senate Pass the New Radio Bill?

OF such importance to the radio fans as well as to the radio industry is the fate of the White Bill in the Senate that POPULAR RADIO has requested a last-minute report on it from one who had been perhaps more intimately identified with it than any amateur in the country. Here it is:

Just as this is written the word comes that the Senate has taken action which would tend to sidetrack radio legislation. In an effort to hasten through impending bills of major importance, the Administration has used every argument which would affect their passage. If the Senate does not take action on the radio bill during this session it will probably be a year before action can be taken at all. Those who have worked so diligently in an effort to put through this legislation during the present session view the possibilities of the immediate future with concern.

There have been many attempts made to have our Congress pass radio legislation since the first radio laws were placed on the statute books back in 1912. Most of these efforts have been made as the result of the desires of a particular class or of a particular organization. Always—and mainly on this account—the attempts have given rise to controversies as they have been brought before the Congressional committees for hearings. Notwithstanding the many attempts, no changes in the laws of 1912 have yet been effected.

Unlike past attempts at revision of radio legislation, the present bill (which is known in Congress as the White Bill) came about as a result of a conference of radio men called by the Secretary of Commerce, Herbert Hoover. The interests of the Army, the Navy, the commercial companies, the amateurs and the general public were all well taken care of and were fully represented at the conference. Secretary Hoover appointed a committee of representative radio men whose recommendations were drafted into the bill.

The hearing on the White Bill before the Committee of Merchant Marine and Fisheries was a short one. No objections of importance were raised to the bill as framed; most of the comment had to do merely with the clarification of certain phrases.

For example: the amateurs wanted to be recognized by law in such way that their future would be secure, while certain commercial companies wanted the wording of the bill to be changed so as to differentiate between lawful and unlawful monopolies.

From all appearances, it was upon this point of differentiation between lawful and unlawful monopolies of radio that the fate of the bill in the Senate hung. One of the Senators from Texas wished to so amend the bill as to prevent the creation of a radio monopoly. As soon as it appeared that considerable discussion and delay was inevitable, the whole measure was sidetracked.

The efforts of Secretary of Commerce Hoover have been so productive of results in the past, and his abilities to show the great need for this legislation have proven so potent, that in all quarters there is hope that even yet some action may be taken, but the indications are that action during this session is unlikely.

Legislation that will modernize present radio laws is an absolute necessity. Everyone who is getting the least of enjoyment out of radio broadcasting and the operation of amateur receivers and transmitters is vitally interested in securing legislation at the earliest possible moment. Possibly an extra session of the Congress will be called; there is some likelihood of it. On the chance that a session will be called, it is recommended that those who have the welfare of radio at heart continue to forward communications to their Senators and Representatives urging action.

Send this message to your Congressman and to your Senator at Washington:

"I favor the radio bill, H. R. 11964."

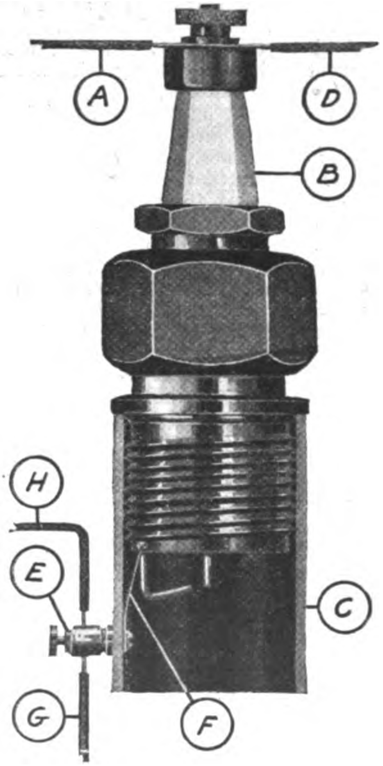
And sign it with your name and address.

PAUL GODLEY

Radio Holds the Hotel Bread Line

ENTERPRISING hotel managers have been quick to seize upon radio as a means for bringing in good entertainment for their guests at a low cost. Last summer the broadcast concerts of the great New York Philharmonic Orchestra (initiated by this magazine) were received in tiny hostelries that could not even support a pianist! How the same idea is being adapted on western ranches is told in this letter from Los Angeles:

> The Fontana Farms Company has an 18,000-acre ranch six miles west of San Bernardino. Recently the ranch opened up for sale 2,000 acres of young vineyards, and every Sunday brought to the place carloads of possible buyers. As many as a hundred guests have registered at the ranch dining-room for Sunday dinner. But as the seating capacity was only fifty, the manager was confronted with the problem of entertaining guests while they waited their turn at the table.
>
> Radio solved his problem. He purchased one of the largest radio sets he could find in all Southern California, and installed it with loudspeaker in the reception room. This outfit, which is of the short wave regenerator type, is capable of being tuned from 200 to 600 meters and easily picks up messages from as far away as Denver. The idea is being adopted by other hotel owners.
>
> CLARENCE M. LINDSAY



HOW THE TRANSFORMATION IS MADE

Here are shown the details of the converted spark plug. A is the aerial wire; B is the insulating column of the plug; C is the fibre tube; D is the aerial connection to the set; E is the extra binding post; F is the connecting wire; G is the ground wire and H is the ground connection to the set.

* * *

How to Convert a Spark Plug into a Lightning Arrester

HAVE you a little lightning arrester in your home? If not, you can make one yourself out of a spark plug and save a tidy little sum of money into the bargain. A correspondent from Kansas City tells in this letter how to do it:

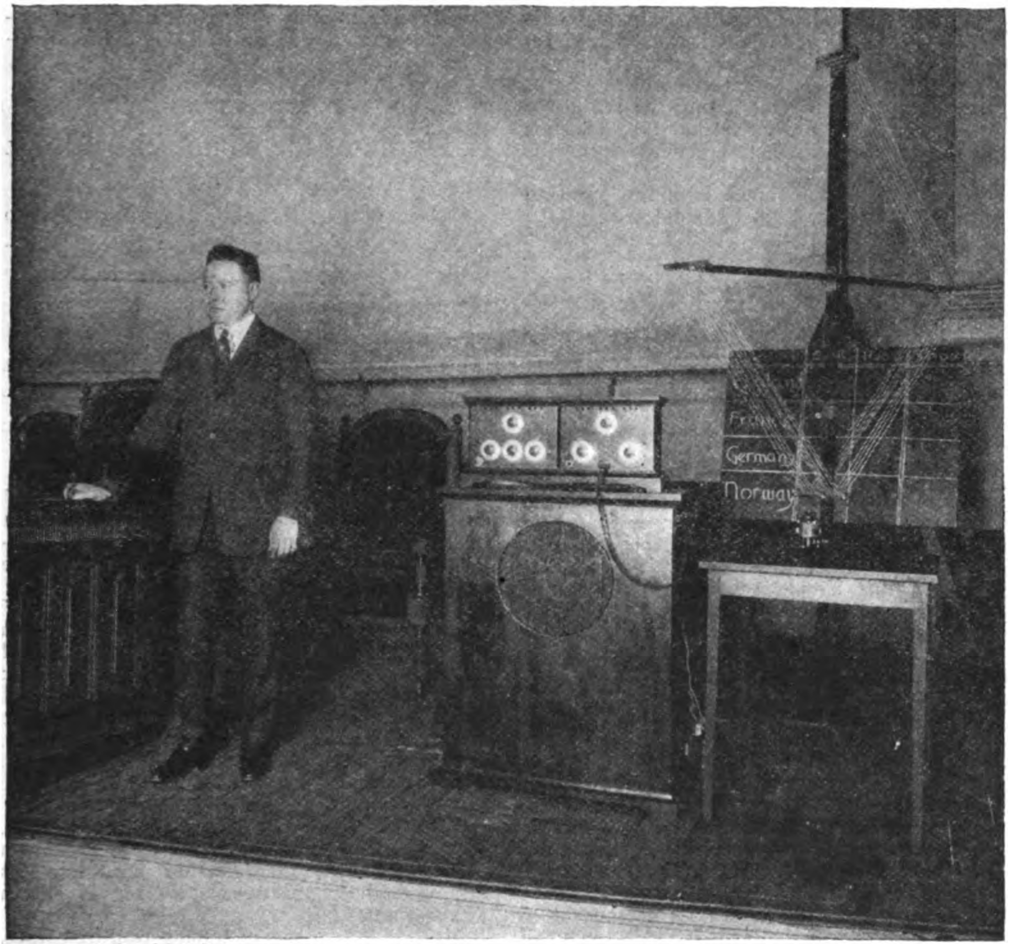
> An efficient lightning arrester for outdoor use can be made from a spark plug. The plug is used complete and must be in good condition. A wire is soldered to the metal body of the plug, then a 2-inch length of fibre tubing is pushed up over the threads. Near the bottom of this fibre tube, a binding post is mounted, and the other end of the wire soldered to the metal body is connected to this binding post, as is shown in the diagram on this page. If this arrester is used in an upright position, the bottom need not be sealed. In use, the aerial lead-in is connected to the plug terminal and the ground connection is made at the binding post.
>
> MARION J. ESTES

* * *

A Startling Announcement by Radio

FROM "the great open spaces, where men are men" comes this unexpected little item; William P. Bear assures us that he heard the announcer of a broadcasting station actually make this naive statement by radio:

> "This is Station XXX. Mr. Jones will now sing *Put Me in My Little Bed* accompanied by Miss Smith."



Radio Corporation of America

COMMUNICATING ACROSS THE ATLANTIC WITH THREE COUNTRIES IN 11 MINUTES

When Mr. Sarnoff recently spoke before a meeting of the Electrical Society in New York he demonstrated, with the aid of radio apparatus on the lecture platform, the possibilities of inter-continental signalling by establishing contact with England, France and Germany in less than four minutes each.

A Condenser-Antenna For Indoor Use

A HOME-MADE indoor loop is usually not an attractive interior decoration and requires a comparatively large space to permit turning to point in the direction of the sending station. A condenser-aerial to take the place of the loop has been devised by a radio fan with an ingenious turn of mind. He writes:

> The condenser aerial here described was installed in a house set in a clump of tall trees and partially shut in by hills rising one to two hundred feet higher than the roof of the house.
>
> The flat tin roof, twenty-two feet above the ground, was first well grounded. On the second floor, which is about half-way between the roof and the ground, a woven wire copper screen, five feet wide by six feet long, was spread on the floor and covered by a rug. This screen forms the aerial; the ground wire for the aerial is connected to a water pipe.
>
> It will be observed that the ground and roof form two outside plates of a large condenser, while the wire screen is the intermediate plate. The dielectric is made up of air, wood and floor coverings.
>
> With this aerial and a simple set good

results are obtained regularly; in comparison with an outside aerial twenty-five feet high and one hundred feet long, the trouble from static is greatly reduced and the signal strength is good. But noting the setting of the tuner with the outside aerial, and then with the screen, when receiving from the same station, it was found that the natural wavelength of the screen is almost identical with that of a one-hundred-foot wire placed outside.

The efficiency of the screen aerial may be better judged when the simplicity of the set is considered. A single variometer in series with a fixed condenser with two taps is used for tuning: one tap of the condenser gives the variometer a range from 200 meter amateur stations to the 412 meter naval station at Anacostia; the second tap permits the 600 meter ship stations to be tuned in.

A single UV-201 tube is used for a detector and the plate circuit is tuned with a second variometer. Each variometer is made of two cardboard tubes carrying eighty turns of wire—forty turns on each tube.

With this simple set the following stations have been picked up regularly during July and August, except on two occasions when local electrical storms were extremely severe: WJZ, 150 miles; NOF, 300 miles; KDKA, 350 miles; WWJ, 450 miles. WGY, twenty miles away, comes in so clearly that the announcer's breathing can be distinctly heard.

The only disadvantage so far observed is that the body capacity of a person walking over the screen affects the tuning; this effect, however, is not noticeable when anyone on the lower floor passes under the screen.

The size of the screen does not appear to be critical except that if it is made too small it does not pick up sufficient energy. In experimenting with a small screen about three feet square it was possible to get the carrier waves from the various broadcasting stations, but the voice could not be distinguished.

T. A. Bryson

* * *

A Home-Made Connecting Block for Extra Headphones

ALL you will need, if you want to make your connecting block yourself, is a piece of bakelite, a small phone condenser and binding posts, the expense of which is less than twenty-five cents. Then follow these directions given by a New Jersey radio fan which are illustrated diagrammatically in the figure shown on this page:

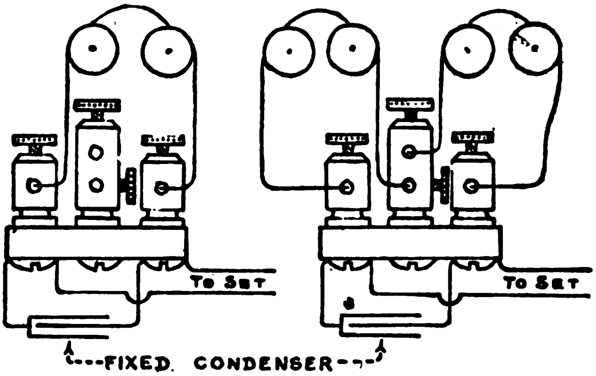
When more than one set of phones is used with a receiver, they should be connected in series. It is best to shunt a small fixed condenser across the circuit, as shown in the diagram.

The block for connecting the two sets of phones is fitted with three binding posts, which are mounted in a straight line. The central post is of the two-hole type and is left "blind": it is not connected in the circuit. The two end binding posts are of the ordinary type and are connected in the circuit in the usual manner. The posts are spaced about ¾ inch apart, and the fixed condenser is connected across the two outside posts.

When only a single pair of phones is used, they are connected to the end posts as shown at the left of the diagram, but when two sets are used, the connections are made as shown at the right.

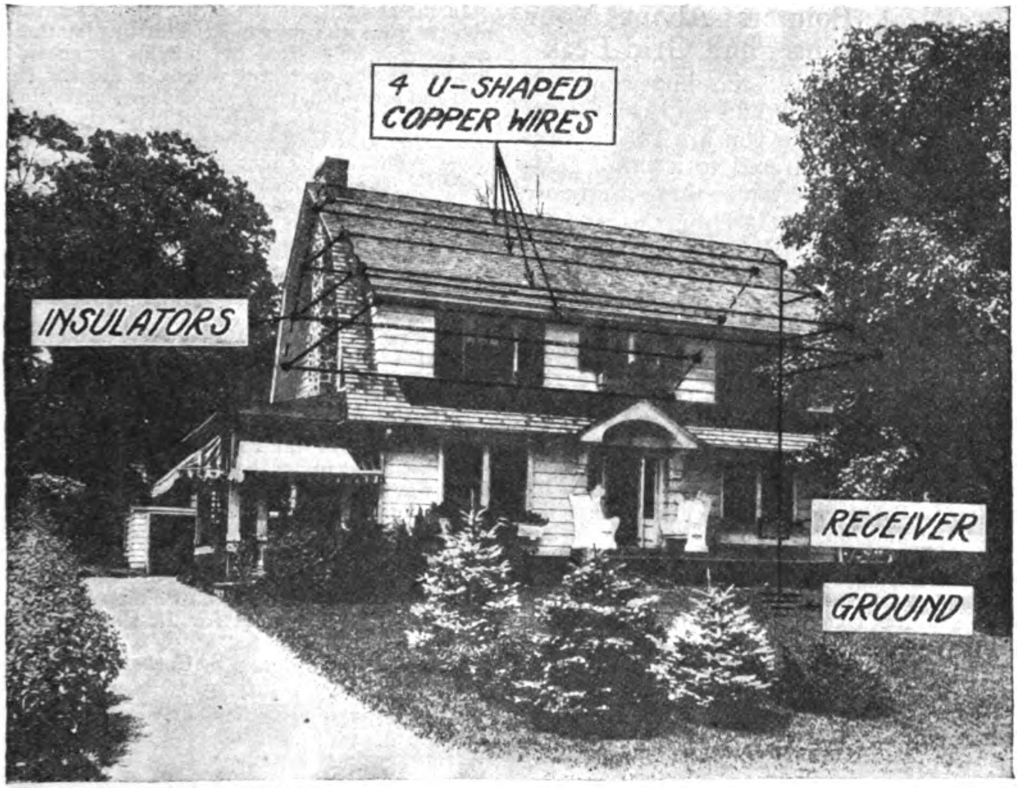
More than two sets of phones can, of course, be provided for by using the desired number of "blind" posts mounted in the same manner.

W. C. Michel



YOU CAN MAKE IT YOURSELF FOR A QUARTER

A small square of insulating material, three binding posts, a small fixed condenser and a few minutes' work, and you have a neat and compact block for connecting your headphones.



From a diagram made for POPULAR RADIO

No more troublesome and unsightly outdoor antennae will annoy the amateur who rigs up his wires under the rafters in his attic—secure from so many of the dangers that threaten the fan's exposed aerial.

An Indoor Aerial with a Crystal Set

AN ingenious radio fan in Elizabeth, New Jersey, finds it impractical to string up an outdoor antenna. So he has solved the problem of a successful indoor aerial for use with a crystal set, thus:

Crystal sets will work satisfactorily with a properly designed indoor aerial, despite the word of "experts" to the contrary. The sets should not, however, be used with a loop antenna.

My house is about fifteen miles from the New York City stations, WEAF, WBAY and WWZ, seven miles from WJZ and about five miles from WOR, WAAM and WBS. At the south end of my attic I put up an insulator and fastened a wire which was, of course, dead ended. I carried it to the other end of the attic to an insulator, carried it horizontally a distance of six inches across to another insulator and back to the end where I began, thence down to the set on the second floor. This was done with four wires fastened on the slanting roof, one below the other a foot apart, making thus four "U" aerials, all joined to one lead-in. The diagram shows how the wires were strung.

By the use of galena or silicon in several different detectors (including home-made ones) I get all the broadcasting stations in the Metropolitan district, some amateur phones and plenty of 200 meter and 600 meter code. As I get the New York City stations but not WHN or WRW, which are twenty-five to thirty miles away, apparently my range with these four "U" pairs is about fifteen miles. I am of the opinion that more pairs would increase the range as well as the signal strength.

With a honeycomb regenerative hook-up, using one stage of amplification and a Baldwin phone, this aerial will pick up enough energy to operate a phonograph used as a loudspeaker.

In cases where it is impossible to set up an outdoor antenna but where there is an attic or other place for the stringing of at least two "U" pairs, and if the location is within fifteen miles of a broadcasting station, this indoor aerial certainly is worth trying on a crystal set.

GUY M. CHASE

Practical Pointers About Your Grid Condenser and Grid Leak

DON'T overlook the importance of your grid leak and grid condenser! Perhaps the trouble you are having with your set may be traced to a cheap grid-leak-condenser; certainly there are many such on the market. How this trouble may be avoided is here pointed out by an old-time amateur:

Two friends of mine who recently installed their first vacuum tube sets have both had trouble from the same causes—defective grid leaks or grid condensers.

In the first case the new set simply did not function. The hook-up was gone over several times, but nothing wrong was found. The tickler and battery connections were reversed; a new ground connection was tried; a new "B" battery was purchased in the belief that the first one was run down, but there was no improvement. I went through the routine of testing for him, and by a process of elimination, I arrived at the conclusion that the fault was in the grid-leak-condenser—a combination affair that he had purchased for about ten cents. There was no need to go further.

In the second case the owner of the set was able to hear the nearby broadcasting stations as soon as he hooked up, but his range was limited to the powerful nearby stations. He also had a combination grid-leak-condenser, but the trouble was found to be not in the condenser but in the grid leak. When another grid leak, made with two binding posts mounted on a piece of fibre and connected with a pencil line, was shunted around the condenser, a great improvement was at once noticeable.

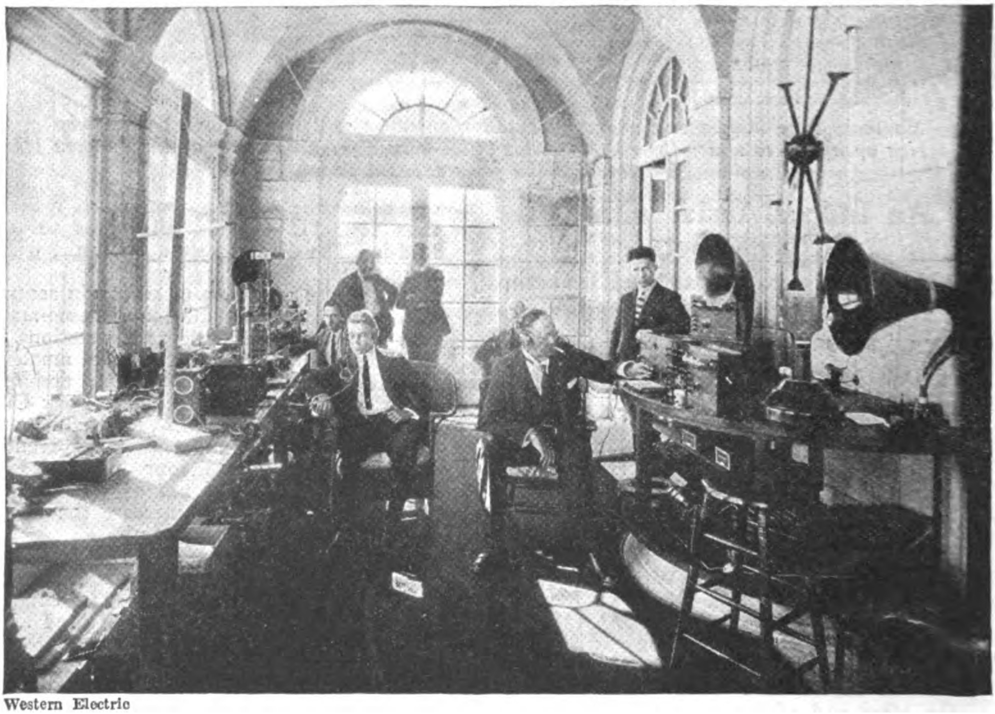
A new and reliable mica grid condenser and leak was finally installed in his set and the trouble which had been given him was remedied immediately.

The first night after we made this change we were able to pick up WGY at Schenectady, 175 miles distant, and a few minutes later KDKA at Pittsburgh, 330 miles distant.

To satisfy our curiosity we ripped apart the combination grid-leak-condenser that we originally used and found that the pencil line in the lead was not continuous, due to the rough surface of the fibre on which the line had been drawn; in other words the pencil only "hit the high spots" of the fibre.

Get a good mica condenser of about .0003 mfd. and a reliable grid leak of 2 megohms and watch your set reach out for the long distance stations.

S. GORDON TAYLOR



Western Electric

ONE OF THE MOST COMPLETE AMATEUR STATIONS IN AMERICA

To advance the radio art, Col. Edward H. R. Green has just completed a remarkable experimental station, WMAF, on his estate on Buzzards Bay, Mass., where he will afford facilities for fans who show promise of making real contributions to science. "No loafers wanted," he warns. "A real inventor does his best work nights and Sundays."

ITEMS of general interest that you ought to know; bits of useful information that every radio fan ought to know.

1,500,000 Sets Owned by American Fans

SOME idea of the rate at which the public interest in radio is "dying out" may be derived from the figures computed by a recent canvass of the country, which indicates that there are now approximately 1,500,000 receiving and transmitting sets owned by radio fans—exclusive of the commercial and governmental apparatus. The center of interest is Pittsburgh, where there is one set to every six houses.

* * *

A Scheme for "Taxing" Outdoor Aerials

THE solons of the City Council of Chicago have apparently been reading about the custom observed by European governments of imposing taxes on amateur sets, and are considering an ordinance that will put a tax of $3.00 a year on receivers and $5.00 on transmitters—in the form of a fee for inspecting outdoor antennas. What will happen when the outdoor antenna is supplanted by the indoor aerial?

* * *

Let the Radio Waves Do Your House-Work!

GEORGE FRANCHETTE, president of the "Society for the Study of Wireless," in France, has just put to domestic service the radio station on the Eiffel Tower. At six o'clock in the morning the radio waves from the tower set his alarm clock going, operate apparatus that closes his windows, turn on the heat and begin boiling his morning cup of chocolate.

* * *

How Radio Is Growing Abroad

THE rapid and inevitable growth of radio abroad is convincingly demonstrated by the government reports which show that the value of radio apparatus exported from the United States in 1922 just about trebled that of goods exported in 1921. Orders during 1922 came from practically every country in the world.

* * *

Radio Matriculates at Yale

DR. LEE DE FOREST, a graduate of Yale University, has established a fund at his alma mater for the purchase of a radio library, another fund for the giving of lectures on radio to advanced engineer students.

Noon and Midnight Time Signals "Interfere"

As Dr. Einstein points out, time is relative, after all, and noon and midnight occur simultaneously at opposite sides of the globe. So it is that radio operators on the Pacific can tune in on the midnight signals from the Honolulu station NPM, and by a quick adjustment can pick up the noon signals sent out from the station POZ in Nauen, Germany.

* * *

The Chief "Reform" Needed in Radio

"FEWER and better broadcasting stations" was the gist of the replies to a questionnaire sent out by the National Radio Chamber of Commerce to fans, dealers and manufacturers.

Kadel & Herbert

THE BELL OF STATION WOR

Fans who have heard the delightful notes of the chimes of the famous Newark station may here see not only this instrument, but also the capable Miss J. E. Koenig, the Manager.

Grand Opera Stalls at Home

Grand opera is now being broadcast in England. Some of the performances at Covent Garden, long the home of this form of musical entertainment in London, are being sent out on the ether by arrangement with the British National Opera Company, in the same manner as the grand opera performances have been broadcast from the Auditorium in Chicago during the past two years and more recently in Philadelphia.

Only the Metropolitan Opera Company in New York still refuses to broadcast programs.

* * *

A Move for Standardizing Radio Parts

At the request of six of the foremost organizations of radio engineers and manufacturers of and dealers in radio apparatus, the U. S. Bureau of Standards called a conference in New York on January 12th with the main purpose of considering whether or not radio apparatus should be made in standardized designs and, if so, how this standardization could best be brought about.

The action of the conference may be summarized by stating that it agreed unanimously:

1. That standards for radio apparatus and service should be formulated.
2. That a broadly representative national committee on radio standardization should be formed under the leadership of the Institute of Radio Engineers and the American Institute of Electrical Engineers, following the procedure of the American Engineering Standards Committee.

* * *

A Transmitting Station on Wings

Aircraft are now following ships in the utilization of radio equipment to add to the safety of the passengers. The first airplane to be licensed as a "limited commercial station" for both transmitting and receiving was the *Airline Arrow No. 1*, of the Airline Transportation Company of Los Angeles. Others are following suit. It is probable that radio will be extensively used in aircraft, especially in those which make flights over the ocean.

* * *

How Many Broadcasting Stations Can the Ether Hold?

January, 1923, was the first month since the beginning of the broadcasting wave that fewer new stations were licensed than were dropped out. This has been interpreted as an indication that 570 licensed broadcasting stations in the Class A and B groups constitute the saturation point, so far as numbers of stations is concerned; from now on the competition will be in quality. A new station, if it is to succeed, will have to offer better service than the old stations.

* * *

The Navy Clears the Ether

Largely because it does not wish to interfere with radio traffic, the Navy is closing several stations following the recommendations of the Rodman Board. The stations already closed are at Cape May, N. J.; Grande Isle, La.; Navassa, W. I.; Pass a Loutre, La., and St. Petersburg, Fla. A station at Seattle will be abandoned as soon as the Navy Yard at Puget Sound can take over the work. Stations at Baltimore, Md., Mobile, Ala., Miami, Fla., and Port Arthur, Texas, will be auctioned as soon as invitations to bid can be sent out. The station at Managua, Nicaragua, will be disposed of when arrangements for commercial facilities have been made. Ten stations in the Great Lakes have been offered to the Army.

* * *

Gold in Antenna Wires

The latest trick for the improvement of radio apparatus is to use gold-plated wire in the antenna. Gold-plated wire does not corrode; its use, therefore, eliminates the high skin resistance which is caused by corrosion.

"MENUS BY MAGIC"

Every morning Miss Florence Davis broadcasts from station WWJ in Detroit daily hints for the housekeeper whose job it is to select the food for dinner which explains why she receives so many letters from grateful husbands!

"STATIONS I HAVE HEARD"

If *you are getting good results with your receiving set, tell your fellow-readers of* Popular Radio *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* How You Are Using It.

A REMARKABLE CRYSTAL SET

The simplest type of crystal set, using a loose coupler, is bringing programs from WOC in Davenport, Iowa, to Toledo, Ohio. Walter Brimmer, fourteen years old, made the coupler himself, from plans published in Popular Radio, using 100 turns for the primary, tapped in tens and units, and 80 turns for the secondary, tapped in tens.

His aerial is a single wire, 85 feet long and 35 feet high. He also hears WWJ, Detroit, Mich., KDKA, Pittsburgh, Pa., and a Cleveland station. Interference is easily tuned out with the coupler, which is one of the best tuning instruments for a crystal set and even for the more complicated tube sets.

* * *

A ONE-TUBE SET THAT SPANS THE CONTINENT

With one vacuum tube, Harry K. Larson of San Francisco hears New York concerts plainly; he also hears most of the other stations in the United States.

The ultra-audion single tube hook-up is used in this set with the exception that the grid leak is connected to the negative of the "A" battery, enabling one end of the secondary coil to be connected to the grid and the other to the plate. The coil in this case was a variocoupler with a variometer in the antenna circuit. A 43-plate variable condenser is also included in the secondary circuit.

As local conditions do not permit the erection of a long antenna, Larson uses three strands 50 feet long and 35 feet high.

* * *

AN ORDINARY DETECTOR TUBE HOOK-UP THAT PICKS UP BOTH CANADA AND CUBA

Station CFCF, Canada and PWX, Cuba can be heard in Atlanta with the ordinary detector tube hook-up, according to H. L. Grosbeck, who has heard some 90 stations with such a set.

The set is home-made, of the regenerative type, with a variocoupler, two variometers and variable condenser.

Grosbeck attributes his success to his cage aerial, which is 12 inches in diameter, with 6 wires 60 feet long, and 50 feet high.

* * *

A USEFUL COUNTERPOISE

A counterpoise is given credit by John E. Carson of Pittsburgh for bringing in signals from Los Angeles with one tube. Carson explains that his success came after considerable experimenting with the regenerative circuit. Many arrangements which brought startling results to others would not work as well for him as some less complicated systems.

His antenna is made of three strands, 110 feet long and 60 feet high. The counterpoise has three strands of similar length which are run 8 feet above the ground.

The set brings in California regularly, as well as Denver, Colo., Winnipeg, Canada, Havana, Cuba, and scores of others in between.

* * *

AN AERIAL ON A TIN ROOF

An aerial but 40 feet long and 15 feet above a tin roof gives one tube a range of half the continent in the set of Homer Brewster in Brooklyn. The aerial is in the form of an inverted L, with 4 wires 35 feet from the ground.

Brewster uses two variometers in his regenerative hook-up and 48 volts on the plate of his detector tube.

Stations WDAP, Chicago, WOC, Davenport, Ia., WHB, Kansas City, Mo., and WGM, Atlanta, Ga., are heard regularly and clearly.

* * *

A SINGLE CIRCUIT COVERS 1,800 MILES

With only one tube in a single circuit regenerative set, George R. Worth of Chicago has heard Los Angeles, Calif., which is 1,800 miles away. He also hears Dallas, Tex., and the larger stations of the Eastern coast under favorable circumstances. Four strands are used in his aerial, which is 160 feet long and slants from an altitude of 55 feet to 40 feet.

* * *

DRY-CELL TUBES AMPLIFY

Three dry-cell tubes bring in New York and Atlanta, Ga., for Arthur F. Walker of Boston, Mass., as well as a number of stations closer to him. He uses a single circuit regenerative set with two stages of audio frequency amplification. His aerial is made of two wires about four feet apart, 30 feet high and 80 feet long.

* * *

WHAT ONE FAN ACCOMPLISHES WITH TWO VARIOMETERS

With the use of two variometers and a single tube, on clear nights Milton F. Conklin of Cincinnati, O., receives from KGW in Portland, Ore., more than 2,000 miles away.

His set is used with a three-strand antenna 140 feet long and 35 feet high.

* * *

A FREAK *RICOCHET*

Covering the distance from Chicago to New York with a crystal set startled Rockaway Beach, N. Y., until the strange feat was explained by Frank J. Bennett, whose regenerative set first caught the waves and relayed them to his friend next door. Bennett's aerial is 200 feet long and runs parallel with that of his friend, which is 50 feet distant.

* * *

International

THE WORLD'S BEST HOME-MADE SET—FOR THE MONEY

The universal success of the $11.00 to $15.00 crystal receiver developed by the Bureau of Standards for the special benefit of amateurs who "build their own" is proclaiming it as a standard of excellence. Its usual range is fifteen miles, but it has on occasion received up to 1,000 miles.

A JERSEY FAN PICKS UP CUBA WITH DRY-TUBE CELL

Stationed in Newark, N. J., L. S. Fisher hears PWX, Havana, Cuba, with a dry-cell tube that requires but 1½ volts to light the filament. He uses a variocoupler and one 43-plate condenser.

The antenna used is a single wire, 140 feet long. It is pointed in the direction of Cuba, which accounts in part for the performance of the tube. The wire is 55 feet from the ground. The ground connection is made in the usual manner to a water pipe.

* * *

NEW YORK HEARS PORTO RICO ON A SINGLE CIRCUIT RECEIVER

Seventeen stations more than 250 miles away are heard with a dry cell tube and single circuit tuner by Allen Berman of New York City. His record for distance is WKAQ, San Juan, Porto Rico.

The aerial is made of two strands 120 feet long and 60 feet high. This forms a fairly good antenna for any kind of set. With the little dry-cell tube it brings in most of the large eastern stations.

* * *

AN AMATEUR SET REACHES 1,000 MILES ON TWO TUBES

With one stage of audio-frequency amplification, James A. Carver has heard 43 stations in 17 different states. He lives in Philadelphia and his record in reception is from WBAP, Fort Worth, Tex., over 1,000 miles away.

The set consists of a variocoupler, variometer, variable condenser and the two tubes. The aerial is a single wire 110 feet long and only 20 feet above the ground. The range of the set could be considerably increased by raising the aerial, but it is possible that this form is fairly well suited to local conditions.

* * *

A 30-FOOT INDOOR ANTENNA

With a single wire 30 feet long strung inside his home, Austin F. Milford of Fort Worth, Tex., receives from Denver and Kansas City by using two stages of audio frequency amplification. His set consists of the ordinary variocoupler, variometer, and 43-plate variable condenser.

* * *

A SINGLE CIRCUIT COVERS 1,800 MILES

With almost the worst possible local conditions, James F. Vincent in Chicago hears New York stations regularly with one tube. His antenna is only a single wire, 100 feet long, running parallel to a 5,500-volt power line, a house circuit and several telephone wires. The telephone wires come within five feet of the antenna at one point.

A regenerative hook-up is used with two coils, a primary coil with 50 turns and a tickler coil with 25 turns. The set is tuned with the tickler and a condenser in the antenna circuit.

NEW LOW PRICES ON

"WORKRITE"

VARIOMETERS

$\$3^{\underline{50}}$

EACH

THE
WORKRITE SUPER
VARIOMETER

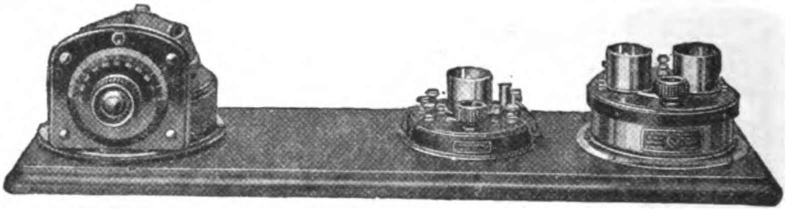
represents the family of WorkRite Radio Parts. Exceptionally well made from genuine mahogany. Has just the right number of turns and air space to make it very sensitive and sharp to tune. Two WorkRite Super Variometers and one WorkRite Super 180° Vario-coupler make the famous WORKRITE TUNER TEAM the most selective circuit obtainable. The price of these instruments has been reduced from last spring's price of $6.00 to $3.50 each now. Order your set right away, and ask for catalog of complete line of "WorkRite" parts.

THE WORKRITE MANUFACTURING CO.

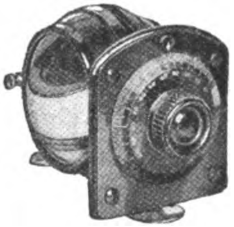
(Branch Offices, 2204 Michigan Ave., Chicago) 5506 Euclid Ave. Cleveland, Ohio

ATWATER KENT

Receiving Sets and Parts



Complete Set consisting of Coupled Circuit Tuner, Detector Unit and 2-stage Amplifier. Other sets shown in circular

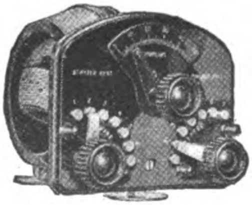


Mounted Variometer

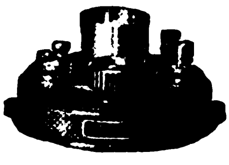
ATWATER KENT Receiving Sets and Parts are built with the most particular care. From the moulding of the condensite forms and winding of the various coils, through the assembling and finishing of the units to the final mounting and wiring, every step is subjected to the most rigid inspection. It must be "just so." This is the reason why Atwater Kent radio equipment has that "different" look that makes it instantly noticeable in any surrounding.

Atwater Kent products would sell on appearance.

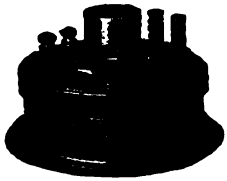
Type 11 Tuner



Mounted Variocoupler



Detector Unit



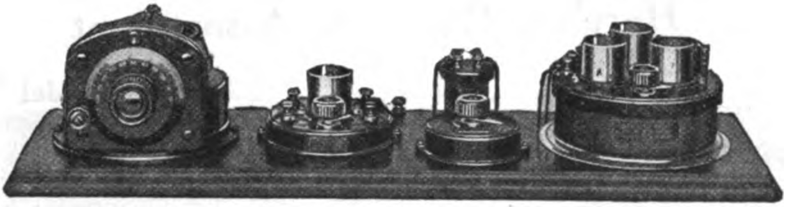
1-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

ATWATER KENT

Receiving Sets and Parts

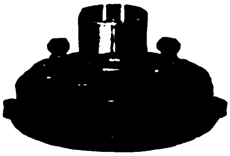


Complete Set consisting of Type 11 Tuner, one stage of Radio Frequency Amplification, and Detector 2-stage Audio Frequency Amplifier

BUT appearance is not the only feature that is watched. Even though the factory is pushed to its utmost capacity by the extraordinary demand for ATWATER KENT sets and parts, every unit is carefully tested to make certain that its performance is right. By this means, the radio fan is sure of getting a part or set that is not only strikingly handsome in appearance, but works perfectly, and gives the utmost satisfaction.

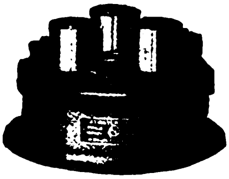
They stay sold on quality of performance.

R. F. Transformer



Standard Vac. Tube Unit

Detector 1-stage Amplifier
A similar unit is furnished
in a 2-stage Amplifier



Detector 2-stage Amplifier

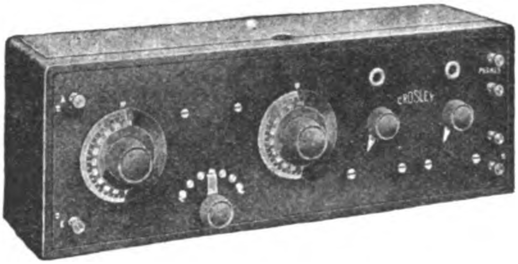
Potentiometer

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

For Radio Frequency Sets

Constantly Making New Distance Records
Here's a Complete Assortment

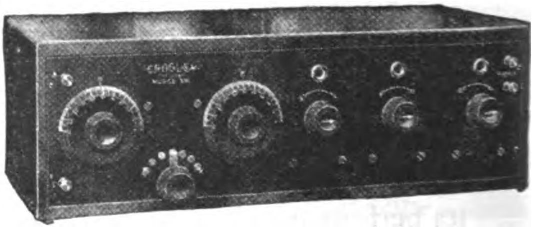


Crosley Model VI

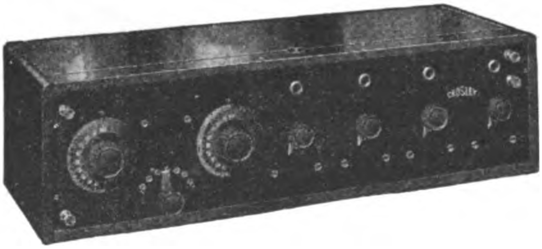
This set consists of one stage of **Tuned Radio Frequency Amplification and Audion Detector.** It is normally for use with **head phones** but is **especially recommended to be used with any type of loud speaker. Additional amplification is unnecessary if head phones and horn are used in receiving local stations.** With the Crosley Receiver Model VI distant broadcasting stations are brought in loud and clear. It also eliminates static to a large extent.

Mounted on formica panel, Adam brown mahogany finished cabinet without tubes, batteries or phones. Price........... **$30.00**

Crosley Model VIII



A new set offering exceptional value. Contains one stage of tuned radio frequency amplification, detector and one stage of audio frequency amplification. Also offered as a portable instrument, using 1½-volt tube. Price, without batteries, tubes and phones. Regular Model VIII, **$48.00,** Model VIII, Portable **$60.00**



Crosley Model X

The most complete receiving set on the market. A 4-tube set consisting of one detector, one stage of tuned radio frequency and two stages of audion frequency amplification. In placing this receiver on the market, we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can compare with it at twice the price. Developed in the CROSLEY laboratories, this unit is absolutely the last word in long range Radio Receiving Apparatus. Used with head phones and loud speaker, it will bring in distant stations all over the house. Price without phones, batteries or tubes **$55.00**

Crosley Receivers

From our smallest complete receiving outfit at $25, including other sets incorporating Crosley radio frequency tuned amplification at $28, $48, $55, and up to our beautiful Console Model XXV, price $150. Crosley instruments offer the highest efficiency at the lowest cost.

CROSLEY

Better—Costs Less

RADIO RECEIVER

Crosley Parts

We also manufacture a complete line of parts for those who wish to make their own outfit. Among these are Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario-Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

CROSLEY MANUFACTURING CO.

416 ALFRED ST. **CINCINNATI, O.**

Crosley ACE

Regenerative Receivers

$20.00 and up

ANNOUNCEMENT

Powel Crosley, Jr., President of the Crosley Manufacturing Company, has acquired controlling interest of the capital stock of The Precision Equipment Company, of Cincinnati, licensed to manufacture regenerative apparatus under Armstrong Patents. Crosley management, production and sales methods already have enabled us to offer even better apparatus at lower prices.

Crosley Model V Regenerative Receiver

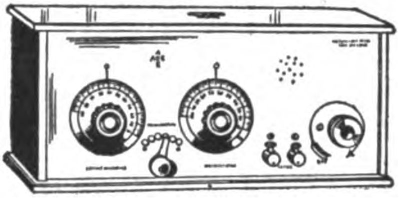
Remarkable records are being achieved by owners of the Crosley Model V regenerative radio receiver, which is the greatest result-producing one-tube set being manufactured today. With a range of from 150 to 600 meters, this little wonder brings in amateur, broadcasting and commercial stations. Concerts broadcast more than 1,000 miles away are heard by those who own the Model V. The cabinets are arranged to permit use of the one and one-half volt tubes, with which they operate very efficiently. Use of these tubes eliminates necessity of buying more expensive "A" batteries. The name "Crosley" is used by permission of the Crosley Manufacturing Company. Made in two models. Both have Adam brown mahogany finished cabinets and beautifully engraved panels. The Crosley two-step amplifier matches this unit perfectly.

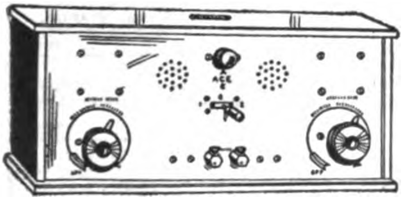
Model V-C $20.00
Model V-D 19.00

Model V-D has overhanging lid, otherwise it is the same as Model V-C.

ACE TRU Regenerative Radio Receiver

No powerful station in the United States is too far away to be copied by owners of the Tru radio receiver. The cabinet of the Tru is beautifully finished, the panel is of genuine formica and all the parts are the most efficient obtainable. Without amplification, the Tru will bring in distant stations loud and distinct. In comparison with any of the highest quality instruments available, the Tru receptor will equal, if not surpass, the performance of any of them. If the owner desires to operate a loud speaker, an amplifier must be added, and we recommend the AV-2, illustrated below. Price of the Tru Receptor (formerly $65), now $35.00





ACE AV-2 Two-Step Amplifier

The AV-2 Two-Step Amplifier designed to be added to the Tru radio receiver, with which it matches perfectly, may be used in conjunction with any audion receiver. Ace type transformers and sockets are used in the AV-2. The cabinet is beautifully finished. The panel is of genuine formica. There is a switch permitting use either of one or two stages of amplification, and also special binding posts for the use of head phones in conjunction with a loud speaker. Experiments have shown that the amplification constant is approximately twenty times that of the incoming signal on the first stage and 400 times on the second. Price of the AV-2 (formerly $65) now..$35.00

ACE Tube Socket

A real good socket, built to stand long and hard service. There is no moulded base to melt when the soldering iron is applied. Instead this is of real sheet formica, one quarter inch thick. Substantial metal die casting—pure phosphor-bronze springs. This socket has been designed to prevent shortcircuiting and burning out of the expensive vacuum tubes. Prong contacts are carefully adjusted. One and one-half volt tubes may be used in these after adapters are inserted.

We recommend the adapters made by the Crosley Manufacturing Company.

Price $1.00

ACE Condenser

Capacity .0005 Mfd.

Exclusive features of this condenser are too numerous to dwell upon. These, however, include balanced non-warping plates, carefully adjusted, and a fine positive gear vernier, with a five to one ratio.

Price with Vernier.... $7.50
Without Vernier 5.00

ACE Transformer

Enormous amplification has been attained and foreign noises have been eliminated through use of the Ace transformer. A generous core of high-grade transformer iron supports rugged primary and secondary windings. The core, in turn, is supported by two nickel-plated cones, which permit of base or panel mounting. Plainly marked terminals through insulation bushings in the shell provide convenient connections in the circuit.

Price $5.00

Licensed under Armstrong U. S. Patent No. 1,113,149, October 6, 1914. For use by radio amateurs in radio amateur stations, to radio experimenters and scientific schools and universities, for use in experimental and scientific schools or university radio stations. The Crosley Manufacturing Company has discontinued the sale of regenerative radio receivers, but Crosley dealers will be able to supply you with those made by the Precision Equipment Company.

WRITE FOR CATALOG OF COMPLETE SETS

THE PRECISION EQUIPMENT CO.

POWEL CROSLEY, Jr., President

416 GILBERT AVE. CINCINNATI, OHIO

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

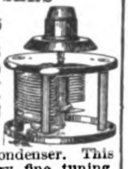
FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

P812—43 plate .001 Mfd. $2.29
P813—21 plate .0005 Mfd. 1.80
P814—11 plate .00025 Mfd. 1.32
P815—3 plate Vernier 1.05

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

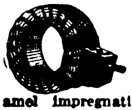
COMBINATION VERNIER VARIABLE CONDENSERS



P824—23 plate .0005 Mfd. Price $3.25
P826—43 plate .001 Mfd. Price $3.95

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

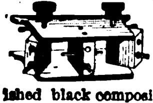
INDUCTANCE "HONEY COMB" COILS



Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	P301	$0.39	P320	$0.97
35	175- 450	P302	.42	P322	1.00
50	240- 720	P303	.49	P323	1.07
75	390- 910	P304	.54	P324	1.12
100	500- 1450	P305	.58	P325	1.16
150	600- 2000	P306	.63	P326	1.21
200	900- 2500	P307	.72	P327	1.30
250	1200- 3500	P308	.78	P328	1.36
300	1500- 4500	P309	.82	P329	1.40
400	2000- 5000	P310	.97	P330	1.55
500	2800- 6100	P311	1.12	P331	1.70
600	4000-10000	P312	1.27	P332	1.85
750	5000-12000	P313	1.43	P333	2.00
1000	7900-15000	P314	1.70	P334	2.38
1250	9750-19500	P315	1.92	P335	2.60
1500	14500-26500	P316	2.18	P336	2.76

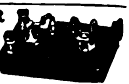
COIL MOUNTINGS



P340 Three coil mounting $3.59
P341 Two coil mounting $2.69

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil

GALENA DETECTOR



Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. P732 Each............86c

This Guarantee Protects You. Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

P105 Detector. Each....$4.45
P110 Amplifier. Each.... 5.95
P115 5 Watt Transmitter 7.70

MYERS TUBES

P113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate Each $5.00
P116 Receptacle for above. Each... 1.00
P117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

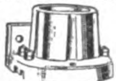
MYERS CHOKE COIL

P119 Each..............................$3.50

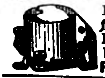
VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs
P140 Each..............39c

PORCELAIN BASE AND TUBE



P144 Crosley for either panel or table mounting 30c



High Grade combination type for panel or table mounting. Metal tube. Highly insulated base.
P146 Each..................45c

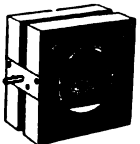
GRID CONDENSER

P162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF.........14c
P163 Same as 162 but higher grade. Enclosed in metal case......39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
P100 Each..........18c

VARIOMETER

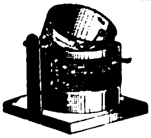


P410—Completely assembled, price $2.69

Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.

P411—Not assembled but all parts complete, except wire, including winding form $1.48

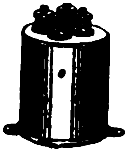
VARIO-COUPLER



With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

P415 Price, completely assembled $2.45
P416 Not assembled, but all parts complete. Price, except wire $1.18
P417 Rotor ball only. Each........29c

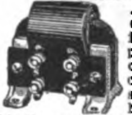
RADIO FREQUENCY AMPLIFYING TRANSFORMER



P995 Each.........$2.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS



As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

P234 10 to 1 Mounted. Each......$3.48
P235 10 to 1 Unmounted. Each.... 2.95
P236 3 to 1 Mounted. Each...... 3.40
P237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

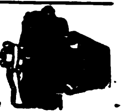
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
P130 Each...............54c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
P132 Each...............48c

POTENTIOMETER

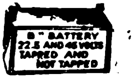
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
P133 Each 98c

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
P135 Each.............78c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

P180 Signal Corps type, small size, 15 cells, 22½ volts. Each, 95c.
P182 Large Navy size, 6½x4x3, 15 cells. 22½ volts. Each.................$1.75
P184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each...............$1.89
P186 Double Navy size 6½x4x6, 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40
P188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
P240—100 ft. coil 45c
P242—500 ft. coil $2.15

Solid Bare Copper Wire, size 12
P244—100 ft. coil 61c
P245—500 ft. coil $2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

P248—100 ft. coil 65c
P249—500 ft. coil $2.95

ANTENNA INSULATORS

P260

P262

P264-6

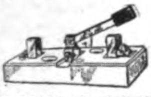
P260 Size 1x3¼. Two for.......17c
P262 Size 2⅛x3¼. Two for.......58c
P264 Size 1½x4. Two for.......80c
P266 Size 1½x10½. Two for $1.35

OUTDOOR LIGHTNING ARRESTER

P980 Price.........$1.68

Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

P385 Single Pole Single Throw. Each 20c
P387 Single Pole Double Throw. Each 32c
P384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

P380—1" Radius
P381—1¼" Radius Each
P382—1½" Radius 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
P386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB

Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

P900 2¼" Diam. for 3-16" shaft. Ea..19c
P901 2¼" Diam. for ¼" shaft. Ea....19c
P904 3" Diam. for 3-16" shaft. Ea.....25c
P905 3" Diam. for ¼" shaft. Ea.....25c
P906 4" Diam. for 3-16" shaft. Ea....42c
P907 4" Diam. for ¼" shaft. Ea......42c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅝ in. thick.

Jacks only:
P390 Open circuit. Each.....43c
P391 Closed circuit. Each....49c
P392 Two circuit. Each......60c
P393 Single-cir. fila. control..69c
P394 Two cir. fila. control..85c

P395 Plug. Large space with set screws for attaching cord. Each............54c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.

P387 Open Circuit Jack. Each......27c
P388 Two Circuit Jack. Each......35c
P389 Standard Plug. Each.........35c

BINDING POSTS

P370-2

P376-8

Brass, polished nickel finish. Washer and 6-32". screw extending ⅝"....

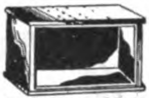
P370 Large size—barrel and knob ¾" long, dozen 85c
P372 Smaller size—barrel and knob 9-16" long, dozen 70c
P374 Large size with composition knob, dozen 60c
P376 Large size with hole for phone tip or wire, dozen......................80c
P378 Small size with hole for phone tip or wire, dozen.......................38c

STORAGE BATTERY

A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.

P194 6-v., 40 amp. size. Each..$10.00
P196 6-v., 80 amp. size. Each....$12.50

CABINETS



Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	P420	$2.48
6x10½"	5½"	10"	7"	P422	2.75
6x14"	5½"	13½"	7"	P424	3.30
7x14"	6½"	13½"	7"	P423	3.60
7x18"	6½"	17½"	7"	P426	3.90
7x21"	5½"	20½"	7"	P425	4.20
9x14"	8½"	13½"	10"	P428	3.70
12x14"	11½"	13½"	10"	P430	4.40
12x21"	11½"	20½"	10"	P432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well with out chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x7	P450	$0.50	P460	$0.75	P470	$0.98
6x10½	P451	.75	P461	1.18	P471	1.47
6x14	P452	1.05	P462	1.55	P472	2.05
7x14	P458	1.20	P468	2.60	P478	2.40
7x18	P453	1.55	P463	2.30	P473	3.10
7x21	P457	1.78	P467	2.65	P477	3.60
9x14	P454	1.60	P464	2.30	P474	3.10
12x14	P455	2.10	P465	3.10	P475	4.15
12x21	P456	3.15	P466	4.65	P476	6.20

BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. **Prices are Transportation Paid.**

P201 For 6 volt battery..........$13.95

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

P770—2000 ohm......$4.00

OTHER STANDARD BRAND HEADSETS

P751 Murdock 56, 2000 ohm......$4.45
P752 Murdock 56, 3000 ohm...... 4.95
P764 Frost 2000 ohm.............. 4.20
P766 Frost, 3000 ohm............ 4.95
P756 Red Head, 3000 ohm......... 5.85
P758 Western Electric, 2200 ohm.. 9.50
P754 Baldwin Type C with universal jack plug $12.00
P755 Baldwin Type C unit...... 5.50
P768 Brandes, 2000 ohm......... 7.15
P789 Holzer-Cabot, 2200 ohm.... 7.20

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

Kellogg Radio Equipment for Better Results

Use, Is the Test

HEAD SETS

The value of extremely light and very small head sets in Radio receiving is most evident when using Kellogg head receivers, which, however, have proved as sensitive and thoroughly efficient as they are light in weight and small in size. The band, too, is especially adaptable and the simple receiver holders, which are held in place on the lower part of the head band by the spring tension of the metal, can be instantly adjusted so as to place the receivers over the ears for the best hearing.

No. 69A Head Set, 2400 ohms, each	$10.00
No. 69C Head Set, 2000 ohms, each	8.00
No. 74A Head Set (single), 1000 ohms, each	5.00

DIALS

All Bakelite. Non-warping, reinforced construction. 5-16 inch shaft with bushings for 1-4 and 3-16 inch shafts included.

No. 501 3 inch Dial	$1.00
No. 502 4 inch Dial	1.25

Kellogg Radio jacks, plugs, condensers, variometers, tube sockets, dials, insulators, coils, variocouplers, microphones, etc., are the best that money can buy.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, CHICAGO

THE ACOUSTICAL AMPLIFIER

BEL-CANTO

TRADE-MARK

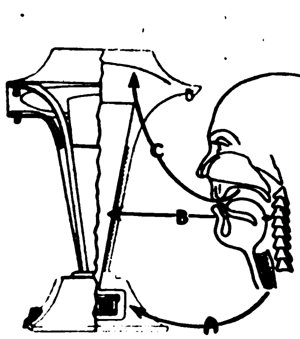
LOUD SPEAKER

Amplifies without Distortion

Built along scientifically correct principles, following minutely the natural functions of the human throat. The unexcelled acoustical amplifier!

> *The receiver is the vocal cord (A); the long tapering inner horn is the throat (B); and the sounding board at the top is the roof of the mouth (C).*

With this superlative amplifier you can readily distinguish the delicate tonal differences between the harp and the piano, even when the two are playing together. A test never before equaled.



Is adjusted for regenerative two stages of amplification, also five tube radio and audio frequency.

Special phone, cord and plug, price $30.00 F.O.B. New York. If dealer can't supply, we can.

Full line of radio parts.

BEL-CANTO CORPORATION

417 East 34th Street New York City

PROGRESS

NATURALLY, at this early stage, the Art of Radio Communication is not standing still. It is undergoing a normal evolution.

The low-hung, straight line automobile of today is unlike its cart-like predecessor of twenty years ago, although the principle of locomotion remains the same.

So, too, the design of Radio apparatus advances. Insulated panels and live shafts are supplanted by metal panels and completely insulated instruments—the obvious thing to do, making unnecessary the use of a shield. Unsightly, protruding knobs are replaced by recessed dials and straight tuning bars, permitting fine adjusting without cramping the hand. The tap switch is removed entirely from the panel and becomes an integral part of the variocoupler, being placed *inside* the rotor, thus eliminating all soldering of primary leads.

It is significant that all these improvements have been developed in the Eisemann laboratories.

Descriptive literature will
be sent upon request

EISEMANN MAGNETO CORPORATION
WILLIAM N. SHAW, *President*

DETROIT BROOKLYN CHICAGO

EISEMANN

Just Consider

—the essential features necessary to make an audio frequency transformer a good one—

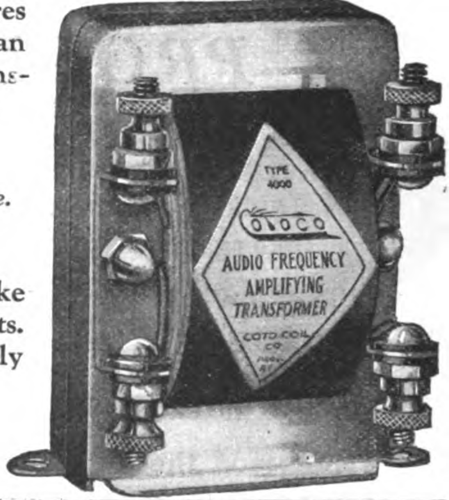
1. *High Amplification.*
2. *Minimum Distortion.*
3. *Low Interstage Linkage.*
4. *Convenient Mounting.*
5. *Compactness.*

Cotoco transformers make these ideal features facts. And the finish will surely please you.

"Built First to Last"

$5.00

At Your Dealer's

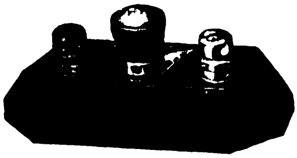


COTO-COIL CO. PROVIDENCE

Pacific Coast Branch, 329 Union League Bldg., Los Angeles

FRESHMAN PRODUCTS—ACCURATE AND DEPENDABLE

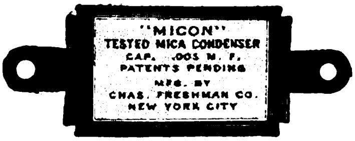
VARIABLE RESISTANCE LEAK



With .00025 mfd. MICON Condenser Combined **$1** Without Condenser **75c**

Unbroken range—Zero to 5 Megohms—Clarifies signals, lowers filament current, increases battery life, eliminates hissing.

"MICON" Tested Mica CONDENSERS



"MICON"
TESTED MICA CONDENSER
CAP. .005 M. F.
PATENTS PENDING
MFG. BY
CHAS. FRESHMAN CO.
NEW YORK CITY

Size	Price
.00025	$ .35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.006	1.00
.01	1.50

Assure absolute noiselessness—clarity of tone—accuracy—constant fixed capacity.

.006 Micons and Variable Resistance Leaks, especially adapted for New Flewelling Super Circuit.

ANTENELLA

No antenna or aerial needed. Eliminates all the inconveniences in radio, operates from any light socket. Price only $2.00.

$2

At your dealer's—otherwise send purchase price and you will be supplied postpaid.

CHAS. FRESHMAN CO., Inc.
106 SEVENTH AVENUE NEW YORK

How much do you expect your battery to do?

TURNING the dials with a battery that is a constant offender is not much fun. You cannot thoroughly enjoy radio broadcastings unless your battery is up to the job.

Exide Radio Batteries are conservatively rated and give full ampere-hour capacity. They maintain steady voltage and deliver uniform filament current to the tubes. From plates to connector terminals each detail is the result of experience gained in every field of battery service by the oldest and largest makers of storage batteries in the world.

Exide Batteries play a leading role in the industrial world. They propel trucks, mine locomotives, and submerged submarines; they operate the fire alarm system and send your voice over the telephone. Most of the government and wireless commercial stations are equipped with Exide Batteries.

Your radio dealer will show you an Exide Radio Battery, or you can get one at any Exide Service Station.

Exide
BATTERIES

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia, Pa.

Service Stations Everywhere
Branches in Seventeen Cities

$45.00

CHELSEA REGENERATIVE RECEIVER

A Real Broadcast Receiver

Range 150 to 800 meters

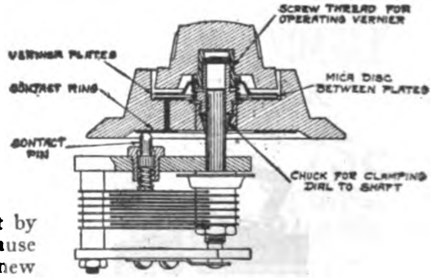
- ¶ Perfection in design
- ¶ Pleasing appearance
- ¶ Simple and accurate tuning

A Chelsea product, embodying Chelsea equipment throughout.
Licensed under Armstrong U. S. Pat. No. 1113149. For amateur use only.

Write for our new No. 7 Catalogue

CHELSEA RADIO COMPANY
177 Spruce Street **Chelsea, Mass.**

HERE! The New "UNITED" VERNIER DIAL ASSEMBLY


SCREW THREAD FOR OPERATING VERNIER
VERNIER PLATES
ADJUST RING
MICA DISC BETWEEN PLATES
CONTACT PIN
CHUCK FOR CLAMPING DIAL TO SHAFT

An electro engineering triumph which attains a hitherto impossible fineness and selectivity of tuning.

The ordinary condenser, in conjunction with the human hand, is faulty—even crude—that is the reason distant stations cannot be tuned in at will. The air is always full of signals, but many times you pass right by a most desirable concert from a far away station because you are not able to tune fine enough to bring it in. Our new Vernier Dial Assembly can be attached to any plate type Condenser on the market, and has given, in actual practical tests, twice as fine adjustments as any 3-plate Vernier. It makes possible that infinite precision in tuning which every radio fan desires.

Circuits in the dial are separated by a mica insulated gap between large area copper plates. Vernier adjustment is controlled by small knob operating a delicate screw thread. Large knob controls plate motion.

Like all "United" Radio products, this new Vernier dial assembly is a fine example of accurate workmanship from an $800,000 plant equipped with the latest precision tools and backed by a staff of trained radio engineers and experts. Price of Vernier Dial Assembly, each....................$2.50

Send for Bulletin.

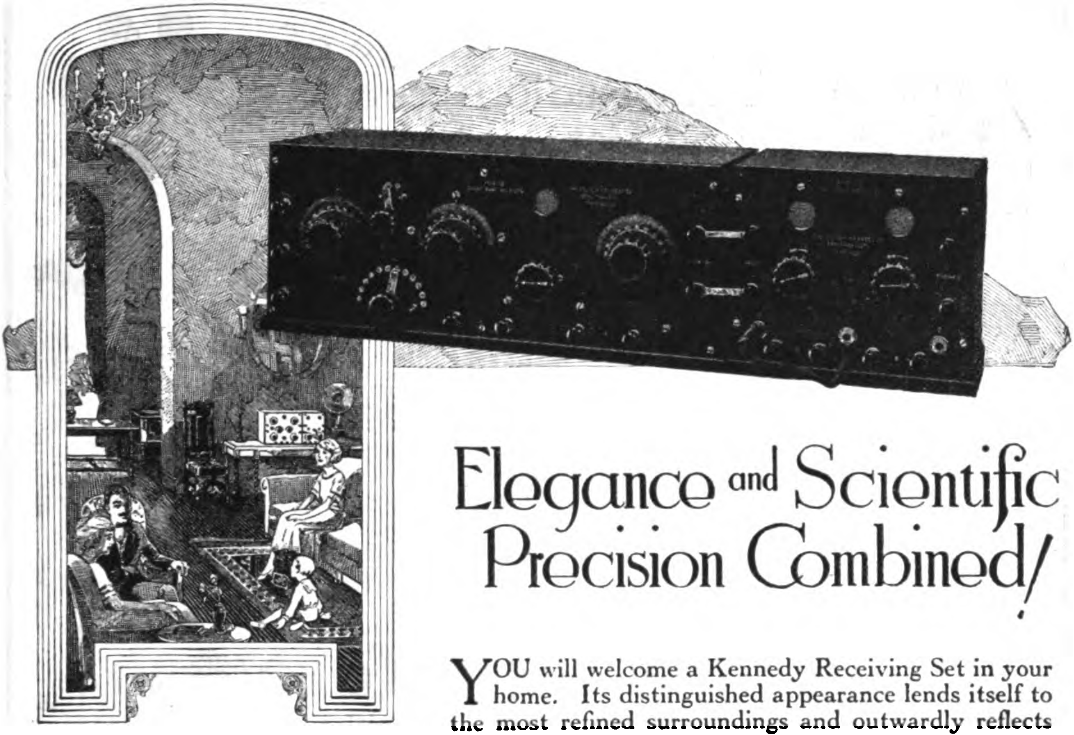
"UNITED" CONDENSER
with Vernier Dial Assembly

43-plate - each $6.50 23-plate - each $6.00 11-plate - each $5.50

Also ask for information and prices on our plain Variable Condensers.

UNITED AUDIO FREQUENCY TRANSFORMER
Magnetically shielded, ratio 5 to 1.
Adopted as standard by leading manufacturers—$4.50.

UNITED MFG. & DISTRIBUTING CO. 536 Lake Shore Drive,
CHICAGO



Elegance and Scientific Precision Combined!

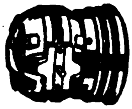
YOU will welcome a Kennedy Receiving Set in your home. Its distinguished appearance lends itself to the most refined surroundings and outwardly reflects the accuracy and precision exercised in its manufacture.

In a cabinet of beautifully finished hardwood and mounted behind a richly polished panel you will find a series of precision instruments—each correctly designed in itself and each exactly co-ordinated with the balance of the set.

Ease of control, long distance reception, elimination of interference and the utmost pleasure and satisfaction in its use are assured with a Kennedy receiver.

Arrange with your Kennedy Dealer for a demonstration. Or write us direct for further information.

THE COLIN B. KENNEDY COMPANY
SAN FRANCISCO SAINT LOUIS



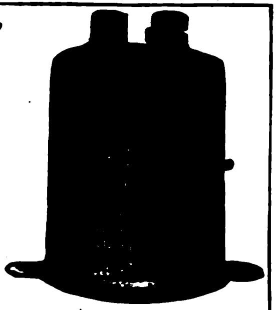
The Kennedy Variometer

This, as well as all other parts, is scientifically constructed by Kennedy artisans. The minute clearance between rotor and stator, the firm windings and positive contact eliminate dielectric losses and increase sharpness of tuning.

KENNEDY

The Royalty of Radio

Widen the Range of Your Radio Receiver and Get All Signals Clearer



Clear, powerful long-distance radio reception is chiefly a matter of *amplification*. By equipping your receiving set with

"All-American" Amplifying Transformers

(RADIO and AUDIO Frequency)

you add wonderfully to the power and range of reception. Signals ordinarily so faint that they can be heard only thru headphones come in clear and strong thru any good Loudspeaker.

R-10—Radio Frequency (150-500 meters)	$4.50
R-12—Audio Frequency (Ratio 3 to 1)	4.50
R-13—Audio Frequency (Ratio 10 to 1)	$4.75
R-21—Audio Frequency (Ratio 5 to 1)	4.75

Ask your dealer for them, and insist on getting "ALL-AMERICAN" or nothing. If none of your dealers handle the line, send order to us with dealer's name and address, we'll see that you are supplied promptly.

FREE Book of Hook-Ups. Gives over 25 diagrams of the latest Radio and Audio circuits. Send 2c stamp for postage.

ALL-AMERICAN

RAULAND MFG. CO.
35 So. Dearborn St., Chicago, Ill.

ALL-AMERICAN

Built on Honor

The Acid Test

Gently tap one terminal of Ambassador Phones on a cent, or your tongue, and a faint "click" will be heard.

(Other phones will not stand this test.)

Type A B	Prices
2000 Ohms	$5.00
3000 Ohms	5.50
4000 Ohms	7.00
5000 Ohms	8.00

Individuals may order by mail and we will gladly ship C. O. D.

Ambassador
RADIO-PHONES
The PHONES THAT STAND THE ACID TEST
Finest in the World at the Price

$1000 REWARD

to anyone showing proof of our refusing to stand back of our guarantee on Ambassador Phones.

Specifications

Adjustable (navy type) head-bands, comfortable and strong, beautifully nickeled.

Case of heavy stamped aluminum.

Cap of finest hard rubber and unbreakable.

Coils wound with highest grade enameled copper wire.

Magnets of Chrome steel will retain their power for years.

5 foot cords—best grade tinsel.

Weight, 12 ounces. Shipping Weight, 1 lb.

Our Guarantee

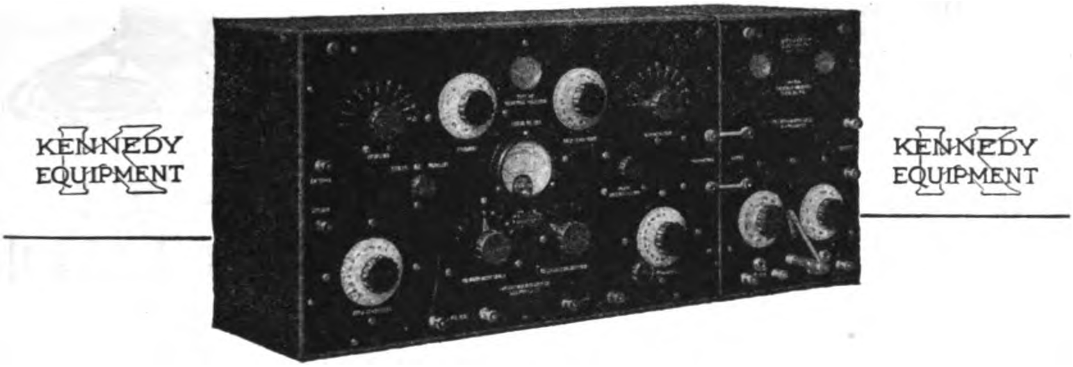
If you are in any way dissatisfied with our product, return same within thirty days and your money will be refunded on request

Special Discounts to Dealers

TOWER MANUFACTURING CO. - 114 Station St., Brookline, Mass.

KENNEDY

uses



Formica Panels and Insulation

THE COLLIN B. KENNEDY COMPANY uses Formica exclusively for its panels, tubes and other insulating parts in its entire line of Receiving Sets.

The handsome appearance of Formica, its high dielectric strength and wonderful uniformity meet the exacting Kennedy standards and have contributed to the creation of the splendid Kennedy reputation.

A list of the companies that use Formica Insulation reads almost like a directory of the leading independent radio manufacturers.

This patronage of men who know radio insulation establishes Formica's claim to leadership in its line.

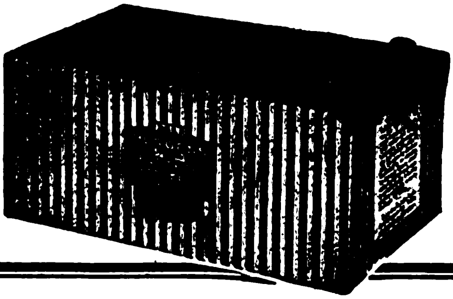
DEALERS: Formica advertising and sales support is the most aggressive and effective in the industry. The Formica Insulation Company treats you right.

The Formica Insulation Company
4641 Spring Grove Avenue
Cincinnati, Ohio

SALES OFFICES

50 Church St., New York, N. Y.
422 First Ave., Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Bldg., Toledo, Ohio
1210 Arch St., Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Bldg., San Francisco, Cal.
Whitney Central Bldg., New Orleans
414 Finance Bldg., Cleveland, Ohio
9 S. Clinton St., Chicago, Ill.
313 Title Bldg., Baltimore, Md.
47 King St., Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS



BURGESS
RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.

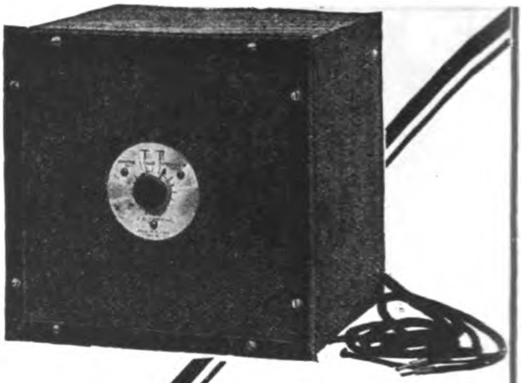
BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

BURGESS BATTERY COMPANY
Engineers Manufacturers
Dry Batteries
Flashlight Radio Ignition Telephone
General Sales Office:
Harris Trust Bldg., Chicago
Laboratories and Works:
Madison, Wisconsin
Branches:
New York Boston Washington St. Paul
Kansas City New Orleans

In Canada: BURGESS BATTERIES, Ltd.
Winnipeg Toronto Montreal

BURGESS
RADIO BATTERIES
"ASK ANY RADIO ENGINEER"



IT DOES WHAT YOU WANT IT TO DO!

BECAUSE of its unique amplification adjustment which allows you to get the utmost from your set, whether receiving distant stations or powerful local broadcasting.

DON'T CONFUSE THE TIMMONS TALKER with the ordinary horn type of loudspeakers—it is self-contained in a beautiful solid mahogany cabinet (approximately 10" x 10" x 9") and requires no extra batteries. It has no delicate mechanism to get out of order.

YOU WILL BE DELIGHTED with its rich, mellow tone and beautiful appearance. To own a TIMMONS TALKER is to achieve real radio refinement. It is sold by most worthwhile dealers; we invite your correspondence if not sold by your dealer.

DEALERS

TIMMONS TALKER

We have a most attractive proposition that will appeal to both dealer and jobber.

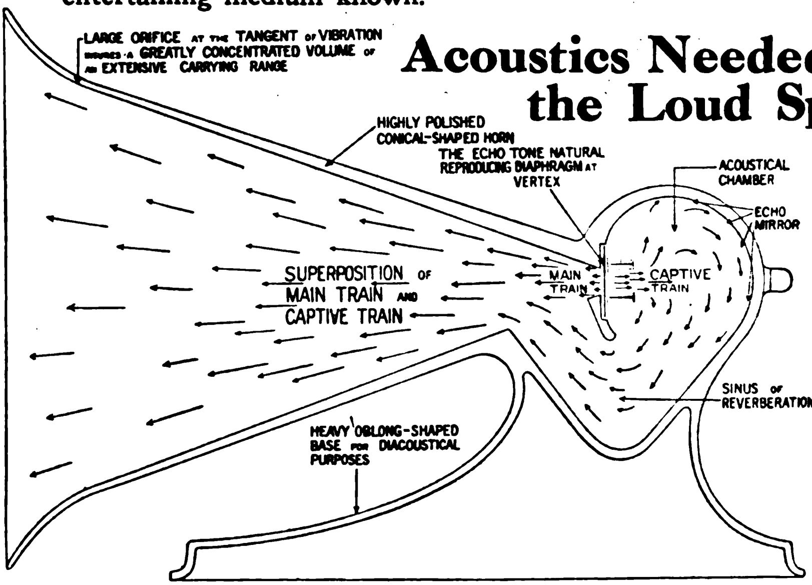
We will be glad to ship any dealer or jobber (with privilege of return) an instrument C. O. D. for inspection.

J. S. TIMMONS
337 E. Tulpehocken St.
PHILADELPHIA, Pa.

Echo-Tone Places Radio Among the Fine Arts!

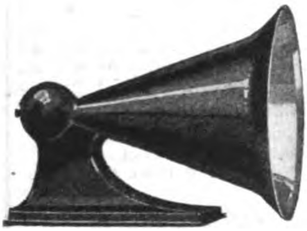
A standard long-distance receiving set equipped with an ECHO-TONE now is considered to be the latest musical instrument and the most diversified entertaining medium known.

Acoustics Needed to Perfect the Loud Speaker


LARGE ORIFICE AT THE TANGENT OF VIBRATION INSURES A GREATLY CONCENTRATED VOLUME OF AN EXTENSIVE CARRYING RANGE
HIGHLY POLISHED CONICAL-SHAPED HORN
THE ECHO TONE NATURAL REPRODUCING DIAPHRAGM AT VERTEX
ACOUSTICAL CHAMBER
ECHO MIRROR
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
MAIN TRAIN
CAPTIVE TRAIN
SINUS OF REVERBERATION
HEAVY OBLONG-SHAPED BASE FOR DIACOUSTICAL PURPOSES

Echo-Tone is more than a loud-speaker, it is an acoustical instrument. An instrument scientifically designed especially for Radio Telephony. It is heavy for diacoustical purposes, it has its own natural reproducing diaphragm of a secret composition which is non-periodic, and by adopting an acoustical chamber, an Echo-Mirror and a Sinus of Reverberation, it has applied Resonance to the Loud-Speaker.

PATENT PENDING



ECHO-TONE

A Value Which Marks A New Epoch

SPECIFICATIONS

Diameter of horn: 15 inches.
Length of instrument: 20 inches.
Base: 15 inches x 6 inches.
Over All Dimensions: 15 x 16 x 20 inches.
Weight: 15 lbs.
Material: Casted aluminum.
Finish: Mahogany grain.

Mechanism: Baldwin Type C Unit equipped with The Echo-Tone Natural Reproducing Diaphragm.

Cord: Black mercerized.

Increased Volume From Any Set. No Extra Battery Or Transformer Used. Operates On One Or Two Stages Of Audio With From 22½ to 135 B Battery Voltage On Plates.

The Workmanship—Material—Performance—and Price are Echo-Tone's Answer to The Public Cry for Better Quality Apparatus.

RETAIL PRICE $35.00

Did You Ever Hear Radio

with a volume, clarity and tone so natural that you would swear the artists were in the room, and with a carrying range so extensive you could hear it plainly thruout your home? Or, is this what you have been waiting for, before you bought a Radio Set? Well, at last, your wait is at an end; for that is what Echo-Tone has given to Radio—and to such an extent that head telephone sets are not even needed to tune in!

Demonstrated in your home on your own set

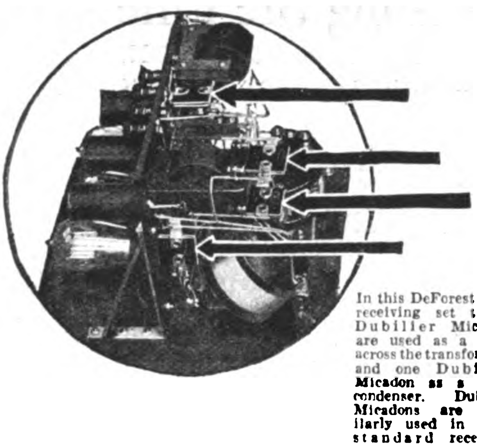
If there is no Echo-Tone dealer near you, send a check or money order for $35.00 direct to us. Upon receipt of the money, we will immediately express an Echo-Tone to you. Try it out on your own set. If it does not prove entirely satisfactory to yourself and family, replace it in its wooden box and give it to the expressman consigned to us. Simply mail us the express receipt, not even necessary to write us your reasons for returning it. As soon as we receive the receipt, we will refund your money, without even waiting until we receive the instrument. Remember, we pay express charges both ways, making it just as convenient as though you were buying in the same city.

Qualified Dealers Wanted

Introducing ECHO-TONE, thruout the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has been allotted to your district. **You deal direct with us—no middle man.**

WILLIAMS RADIO COMPANY

1438 WASHINGTON BLVD. WEST
DETROIT, MICH.



In this DeForest radio receiving set three Dubilier Micadons are used as a shunt across the transformers and one Dubilier Micadon as a grid-condenser. Dubilier Micadons are similarly used in other standard receiving sets.

Why Dubilier Micadons *are used in DeForest Sets*

PERFORMANCE (and therefore the reputation of a radio manufacturer) is so dependent on good condensers that in De Forest radio receiving sets and in others equally well known, Dubilier Micadons are the standard equipment.

Unless a radio receiver is fitted with Dubilier Micadons the broadcasting station is not heard at its best.

The list price of Dubilier Micadons varies from 35c to $1.50 each, depending on the capacity.

Send for descriptive circular.

DUBILIER CONDENSER AND
RADIO CORPORATION
48-50 West Fourth St., New York

BRANCH OFFICES
San Francisco, Cal., 709 Mission St.
Washington, D. C., Munsey Building
St. Louis, Mo., Syndicate Trust Bldg.
Chicago, Ill., 33 So. Clinton St.
Atlanta, Ga., Forsyth Building
Seattle, Wash., 1926 L. C. Smith Bldg.
Pittsburgh, Pa., 704 Granite Bldg.
Los Angeles, Cal., 329 Union League Bldg.
Huntington, W. Va., 1028 Fourth Avenue

Distributed in Canada, by Canadian General Electric Company, Ltd., Toronto

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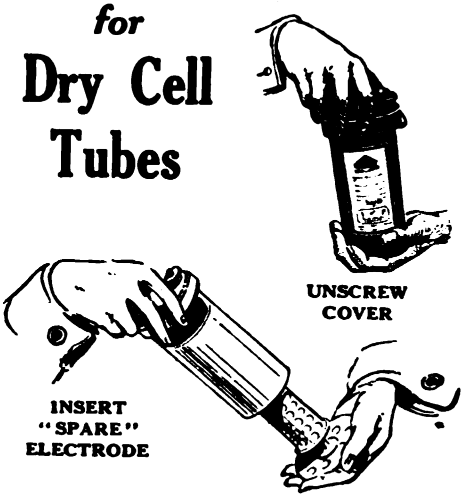
The BEST BATTERY *for* Dry Cell Tubes



Instantly Recharged

"Spare" electrodes exchangeable at your dealer's or direct from us at 40c each.

One 40c MAGNO electrode will operate one to three dry-cell tubes. Furthermore one MAGNO charge lasts several times longer than dry cells. Voltage always sufficient, assuring long-distance reception minus bothersome battery noises.

"Spare" electrodes never run down when not in use. Don't keep buying dry cells. Think of the money this battery will save you, giving at the same time ideal service.

Write today for descriptive folder!

STORAGE BATTERY
MAGNO

Price Only
$4.00

Exchange Electrodes
40c

MAGNO
Storage Battery Corporation
Aeolian Bldg., New York

MU-RAD ★ RECEIVERS
SUPREME

The New Star in the Radio World

Everyday reception over distances that far outstrip the commonly accepted records — this (not baseless claims) is the evidence of Mu-Rad superiority. The only set that can achieve such astonishing sensitivity, using a small loop aerial. Delightfully fine selectivity. With all this efficiency and completeness, utterly simple to operate. Each set guaranteed for 1000 miles reception.

4300 MILES
on an indoor loop aerial

Four thousand, two hundred and seventy-eight miles away in Honolulu, the Royal Hawaiian Orchestra plays for delighted listeners in St. Louis, U.S.A., through their Mu-Rad Receiving Set. An example of Mu-Rad supremacy.

Write For Literature.

MU-RAD LABORATORIES, INC.
809 FIFTH AVE. ASBURY PARK, NEW JERSEY

Double As Good

The scientifically correct design of the *FADA VARIO-COUPLER* enables a very gradual variation of coupling over 180 degrees. Ordinary couplers give only a 90 degree variation, and hence the Fada 180 degree type has double the efficiency.

Its simplicity and high efficiency in signal selection by vernier control of coupling has given the Fada 180 degree coupler universal demand.

Vernier Rheostats

The nationally famous Fada Rheostat with a new Vernier attachment.

No. 150-A Fada Vernier Rheostat........... $1.25

Potentiometers

Mechanically perfect spacing and winding of the resistance wire resulting in smoother adjustment.

No. 152-A Potentiometer (200 ohm)........ $1.00
No. 154-A Potentiometer (400 ohm) 1.00

Fada ingenuity—manufacturing economy—value—guarantee—and low prices, are responsible for the popularity of Fada radio parts.

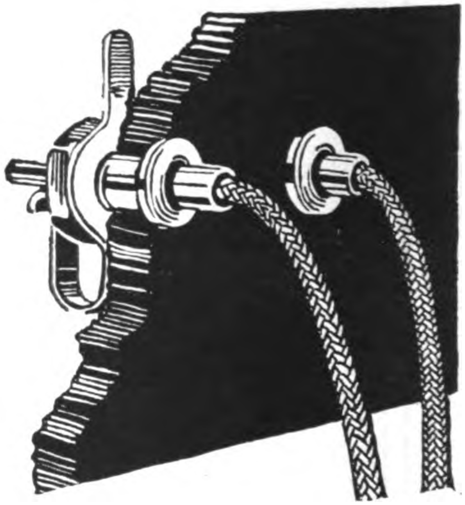
The Fada Handbook gives facts about the use of each radio part, and will be of aid to you in your radio construction work. Send 10c for your copy.

F. A. D. ANDREA
1581-D Jerome Ave. **New York City**

Fada Equipment

Try Them Today!

Quick Connecting
UNION-RADIO
PHONE
TIP JACKS
(Pat. Applied For)
25c A PAIR



These Phone Tip Jacks are now recognized as the greatest small Radio Electrical Device of the age. They replace unsatisfactory binding posts. Easy adaptation, quick operation, positive contact. Attractive in appearance. Soldering lug incorporated, but use optional.

Accommodate any standard round phone tip and several sizes of bare wire. Ideal for W D 11 connections and coil mountings. These Union Radio Jacks **save buying expensive telephone plugs and jacks.** Made to live up to Union Radio Standard of Quality. Only 25c a pair.

FOR ASSURED RESULTS

you should "try out" Union Radio Tip Jacks, Variable Condensers, Rheostats, Vacuum Tube Sockets, Condensite Dials, Complete Receiving Sets and Two Step Amplifiers.

Union Radio Apparatus and Accessories are sold by most good dealers. If you can't obtain them from your local store mail your order to us. Write for a copy of our Catalogue A, Radio Apparatus.

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Write for our liberal proposition.
Dealers' Catalogue A and Price List, also samples sent on request.

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NEW-YORK-OFFICE—116-WEST-32nd-STREET

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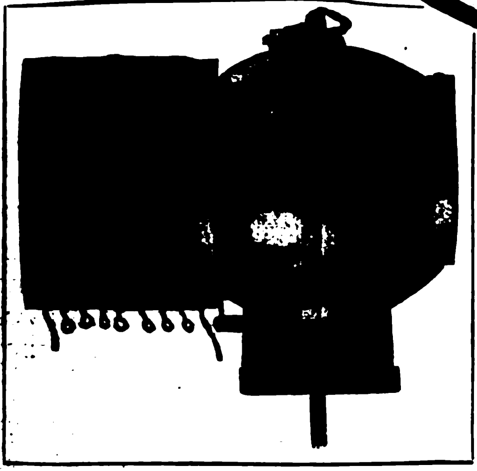
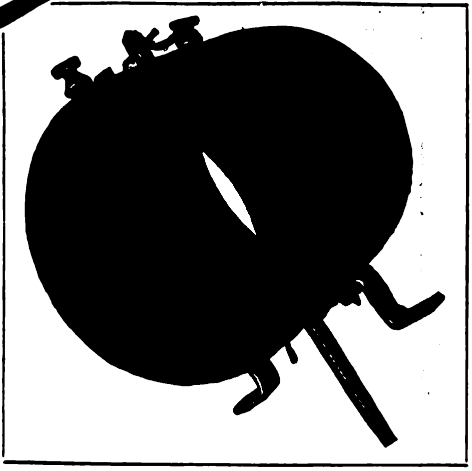
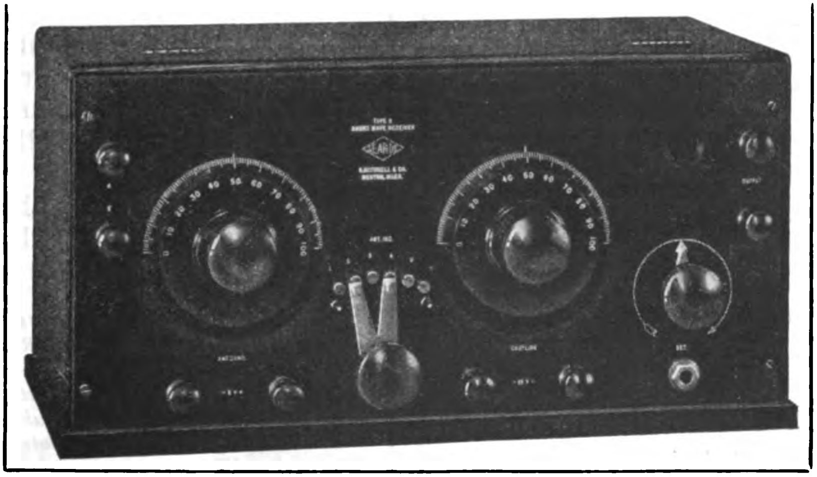


Catalogue No. 165 . . . $13.00



Catalogue No. 166 . . . $5.50



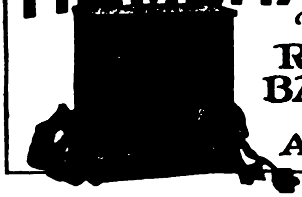
KNOCK DOWN SET TYPE AD $28.00

Range 1000 Miles. Fitted for Std. or WD 11 Tube

R. MITCHELL & CO.

255 ATLANTIC AVE. BOSTON, MASS.

HOMCHARGE *your* RADIO BATTERY *for* A NICKEL



Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery over night for a nickel without removing it from your living room. No muss—no trouble—no dirt—requires no watching.

After the concert connect to any lamp socket, snap the clips on your battery and "turn in." While you sleep the HOMCHARGER is silently charging your battery, the charging rate being governed automatically. In the morning it is fully charged. No OTHER battery charger can boast of such quick and economical performance.

The HOMCHARGER is the only battery charger combining all of these NECESSARY HOMCHARGING features — SELF-POLARIZING — FIVE to EIGHT AMPERE charging rate — UNDERWRITERS' APPROVAL—beautifully finished in mahogany and old gold—UNQUALIFIEDLY GUARANTEED. OVER 90,000 NOW IN USE.

Sold complete with ammeter, etc., by all good radio and electrical dealers for $18.50. ($25.00 IN CANADA.)

See the RADIO HOMCHARGER DE LUXE at your dealer's or write direct for our FREE circular showing why the HOMCHARGER is the BEST battery charger at any price.

MOTORISTS

The HOMCHARGER will also charge your AUTO Battery.

The Automatic Electrical Devices Co.
132 West Third St., CINCINNATI, OHIO

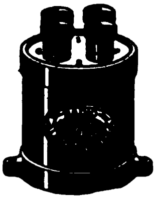
Largest Manufacturers of Vibrating Rectifiers in the World

The New R T-8 Radio Frequency Transformers

on the market March 1st, 1923, are specially designed by the *Radio Service Laboratories* for maximum efficiency when used with any low filament current consumption and low voltage tubes on the market.

For Audio Frequency the new RT-A2 will give you 100% Tone Quality and High Amplification without distortion. For best results on both tone and distance, use *Radio Service Laboratories* Radio Frequency R T-8 (for all stages) in the black case, retail price $6.00 and Audio Frequency RT-A2 in brown case, retail price $6.50. For sale at all reliable electrical or Radio Stores.

If your dealer cannot supply you, order direct. Order by type number, accept no substitute, and remember that all *Radio Service Laboratories* Transformers are individually triple tested and unconditionally guaranteed.



Send ten cents for new booklet on Radio Frequency with schematic diagrams—a most valuable and helpful publication for the radio amateur and expert.

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Brandes

ARE you getting long distance radio stations—are you catching clear and distinct the faintest signals that mark the extreme range of a good receiving set? A Brandes *Matched Tone* Radio Headset will make the faint signals understandable. The two receivers are perfect sound-mates—they are matched in tone to improve the clearness of the message. Brandes *Matched Tone* Headsets are guaranteed to get the best results obtainable from any set.

¶ Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

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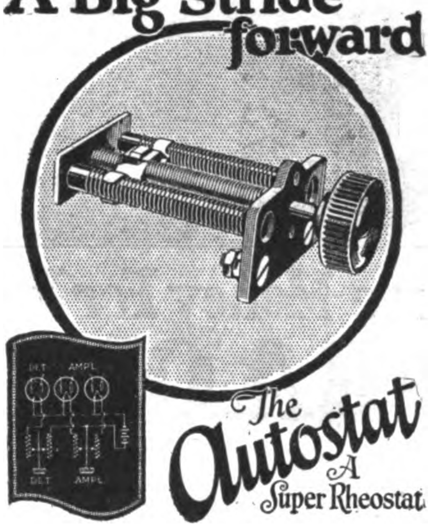
Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

Dept. P.R.

A Big Stride forward



The Autostat

A Super Rheostat

Can be used with 6-Volt or WD11 Detector Tubes, two Amplifying Bulbs, or one 5-Watt Power Tube.

THE AUTOSTAT presents an entirely new principle in filament rheostat construction and radio takes another BIG step forward.

No longer is it necessary to turn a "hair's breadth" to tune in that elusive station, for with the AUTOSTAT you can give the knob a substantial turn and get a superfine adjustment. No other rheostat to date possesses the necessary "fineness" of adjustment to eliminate interference and "tube howls" under all conditions. But the AUTOSTAT, with its micrometer adjustment, will positively give these much-sought-for results.

How It Works

Two parallel mounted resistance tubes are connected in series by a "micrometer-operated" slider—the length of wire in circuit depending upon the location of this movable slider. Forty turns of the AUTOSTAT knob are required to complete the variation from minimum to maximum resistance—against one-half to three turns on others.

This exclusive patented construction means:

1. **One full turn of AUTOSTAT knob produces finer tuning than a "hair's-breadth" turn on any other.**
2. **Economical—only two AUTOSTATS required for a three-bulb set.**
3. **Greatly increased receiving range and clearness of signals.**
4. **A uniform change in resistance with each turn of the AUTOSTAT knob.**
5. **Indestructible wire-wound fireproof lava resistance element.**
6. **Unqualifiedly guaranteed.**

***Popularly priced,* $1.35**

Dealers

See your jobber or write direct for Radio's most attractive Rheostat proposition.

The AUTOMATIC ELECTRICAL DEVICES CO.
132 W. Third St., Cincinnati, Ohio

Builders of Precision Rheostats Since 1914

More Money For You *in* RADIO

THE amazing expansion of Radio has opened up thousands of wonderful new positions on land and sea. Big salaries, fascinating, easy work, short hours, and a wonderful future are offered to ambitious men who get into Radio now.

Take advantage of these wonderful opportunities to step into a big paying position in this great new field. Radio offers you an opportunity to travel and see the world, with all expenses paid, and a fine salary besides. Or you can stay at home and work up to a position paying up to $10,000 a year. One of our recent graduates secured a position one week after graduating, paying a salary of $300 per month.

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Hundreds of men are already earning handsome incomes in this wonder science. If you want to get into a profession where opportunities are unlimited make Radio your career—become a Certified Radio-trician.

Thousands of Certified Radio-tricians are wanted to design Radio sets; to make new Radio improvements; to manufacture Radio equipment and to install it; to maintain and operate great Broadcasting stations and home Radio sets; to repair and sell Radio apparatus; to go into business for themselves; to operate aboard ship and at land stations.

You can easily and quickly qualify in your spare time at home through the help of the National Radio Institute. Prominent Radio experts will help you. Four wonderful instruments are furnished free, making the work thoroughly practical. The same plan that has already helped hundreds of our graduates to real success and real money in Radio is open to you.

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The urgent need for radio experts and the calls which come to us for our students prompt us to make a special offer open to new students for a limited time. Through this special offer your enrollment will be accepted at a special rate, and you will receive, without extra cost, our new course in Wireless Telephony.

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No other field today offers such great opportunities as Radio. Take your choice of the many wonderful openings everywhere. Prepare now to step into the most interesting and best paid profession today. Read about the opportunities open now—the different kinds of work—the salaries paid. Write today for the free 44-page book that tells how America's first and biggest Radio school can make you a Certified Radio-trician in your spare time. Mail the coupon or write a letter NOW.

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Honeycomb coils, all sizes, 20% discount. Space being limited, we are obliged to omit many items.

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Cut Rate Radio Co.

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Riding in the Day Coach is Cheaper

But the greater comfort and convenience of a Pullman chair are certainly worth the difference in price that is asked. In most things—including radio equipment—*you get what you pay for.*

You can buy a single-circuit receiving set for considerably less than you will pay for a Paragon three-circuit receiver. Of course, with a single-circuit receiver you must expect mixed messages, continuous jamming between different stations and generally unsatisfactory results.

With a Paragon three-circuit receiver, you can tune in accurately on the station you wish to hear, on any night that it happens to be broadcasting, and get a complete programme, clearly rendered.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

***Also Manufacturers of* PARAGON**

Radio Telephone Transmitters
V. T. Control Units
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Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
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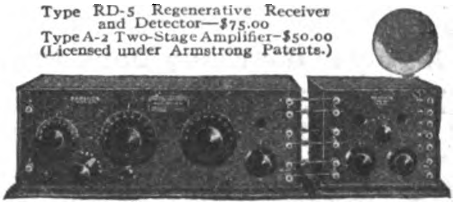

Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
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Complete with Knob and Dial
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Two Biggest Hits In Radio

Regal Inductance Switch

Does away with all drilling of holes in panel. Does away with all switch points. Requires but one hole to attach to panel. Complete 15 point switch in one unit.

Regal Rheostat

A scientific precision instrument. Full exposed resistance wire. More sensitive than a vernier. 6 Ohms resistance —2.2 Amperes.

Condensers, Power Rheostats, Potentiometers, Vario-Couplers, Jacks, Knobs, Dials, etc. Send for our new catalog No. 27.

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"REGAL" RHEOSTAT

Complete with new Regal Knob
$1.00

THE AMERICAN SPECIALTY COMPANY BRIDGEPORT, CONN.

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Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

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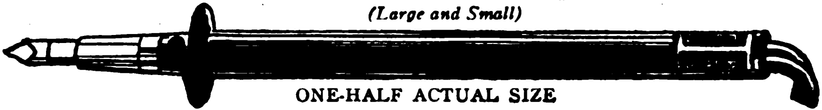

ONE-HALF ACTUAL SIZE

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Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

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Manufacturers of
Ultra-fine Receiving Sets
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ACME
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FREE Illustrated pamphlet comprising sixty-two Duck radio instruments and sets with reductions averaging 30% mailed on request. Send postal today. Any old-time radio amateur will tell you who we are and our reputation. Only a few years ago almost one-third of the radio instruments sold at retail, exclusive of sales in only a half dozen large cities, were sold by Duck.

A Few of the Many Duck Products at Sensational Prices:

Rheostat, 70c; Bakelite moulded positive contact, 70c; Bakelite Moulded Dial, 55c; superselective moulded variometer, $4.65, worth $8.00; radio frequency potentiometer, $1.15; solid mahogany form variometer, $3.60; 43-plate panel-type variable condenser, pigtail connection, $3.15; detector panel, $5.25; receiving set, mahogany cabinet, detector and two stages of audio frequency, $59.50; radio frequency receiving set with one-step radio and detector, $29.75.

SEND 25c in coin or money order for our big 256-page combined radio catalog and text book. For radio information and hook-ups it is worth many times the retainer asked.

THE WILLIAM B. DUCK COMPANY, 227-229 Superior St., Toledo, Ohio

BRISTOL AUDIOPHONE JR.

Loud Speaker

For Radio-Phone Reception the AUDIOPHONE JR. is a strictly high-grade instrument, built to Bristol standard and backed by the Bristol reputation of 33 years.

The Audiophone Jr. is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set.

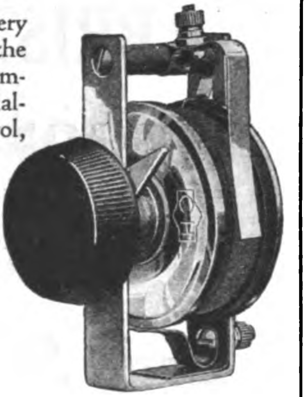
It is a true sound reproducer, bringing to home or public hall the distinctive qualities of the original performance. Characterized by its round, full, mellow tones—its ample volume—and freedom from blurring, mechanical distortion, and metallic effect. It has made radio a real source of restful, refreshing entertainment................................**Price, $22.50**

The Audiophone Jr. can be used with any two or three stage power amplifying outfits. Where two stage amplification does not give the desired volume, the range of the Audiophone will be made ample by the addition of a Bristol One Stage Power Amplifier ....**Price, $25.00**

Bulletin 3006—L on request—Demonstrations arranged for

THE BRISTOL COMPANY
Waterbury, Conn.

Increase Your Range



This new "A" Battery Potentiometer by the engineers of Cutler-Hammer, world-known specialists in rheostatic control, will bring new stations to your receiving set, and give you increased signal strength for better reception.

It is correctly designed for maximum service—with a resistance unit that cannot be displaced under constant usage. Demand the C-H trademark—*it is your guarantee of satisfaction.*

Resistance 300 ohms. Panel Mounting. Pointer Indicating. Adjustable Contact Fingers. Genuine Thermoplax Knob Convenient Binding Posts for easy wiring. Finished in dull satin nickel.

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C-H RADIO "A" BATTERY

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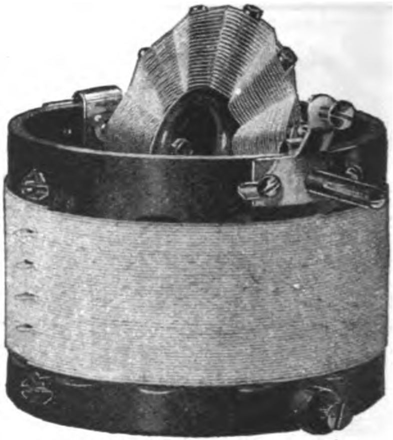

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WITH

SPIDER WEB ROTOR

PROVIDES

REMARKABLE SELECTIVITY IN TUNING

Designed for us by Alfred A. Crossley

Price $6.50

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THE HARTMAN ELECTRICAL MFG. CO.

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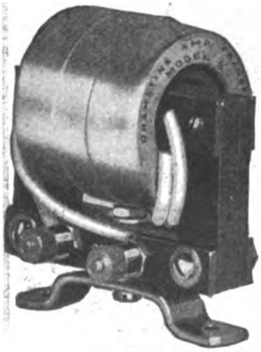
RHAMSTINE*

Amplifying Transformer



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$4.00

Postage 10c

with W D-11 TUBES

It is the peer of them all.

Write for Free Catalog!

Dealers: Send for discount sheet on Rhamstine* Products!

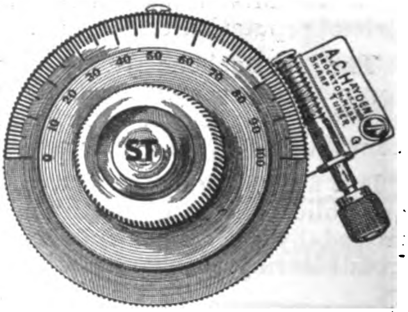
Manufactured by

J. THOS. RHAMSTINE*

2162 E. Larned St. Detroit, Mich.

****Maker of Radio Products***

Use ACH SHARP TUNER DIALS



YOUR CHOICE OF

Rough tuning with dial, or one thousandth of an inch in either direction with the Sharp Tuner Knob. Both controlled by center Knob ST. Eliminates a Vernier condenser.

Can be installed on any set, making difficult tuning easy.

GUARANTEE

If purchased direct and you find the ACH Dial does not warrant your own personal award of merit, return it and we will refund your money. What better guarantee can we give?

Price of ACH 3-inch Dial Complete $2.50

A. C. Hayden Radio & Research Co.

BROCKTON, MASS., U. S. A.

Mail Orders sent prepaid in U. S. A.

Popular!
-for good reasons

RADIO enthusiasts wanted an expertly designed, moderate-priced set that any intelligent man or woman could operate. So we built the Popular, to sell at a popular price.

Just two dials to turn to find the stations broadcasting within a range of 500 miles. As you become more experienced you can reach out twice as far. You don't have to become an expert to operate this set to your complete satisfaction. But the more you know about radio, the better you will appreciate it.

The fine piano finish mahogany case, moulded and shielded panel, Bakelite dials and splendid beauty of the Popular promises you a set you will be proud to own. And that promise comes true! It is the ideal set for busy folks who want the thrills of radio.

THE C. D. TUSKA CO., Hartford, Conn.

Popular No. 225
Tuska Regenerative Receiving Set
Tuska receiver, detector and 2-stage amplifier. Armstrong regenerative circuit, licensed under Armstrong U. S. Pat. No. 1,113,149. Sensitive for long-range stations. Loud volume for nearby broadcasting. Clear, natural and undistorted tones. Can be used with phones or loud speaker.
Send for Catalog No. 15

TUSKA RADIO

WHY METRO HEADPHONES ARE SUPERIOR

Permanently Sensitive !

METRO Headphones will always respond as distinctly to the slightest impulses as they did the day you purchased them. The magnets upon which their sensitivity depends, are made of highest quality tungsten steel, put through a special heat treatment, magnetized and then carefully "aged" to a uniform magnetic strength. These magnets will not weaken or lose their magnetism: If you want lasting sensitivity, you should insist on *Metro Headphones.*

Price $6.00

Little Giant Receiving Set
A surprisingly compact set
Cabinet, highly polished American Walnut finish. Simplest, easiest tuning device. Complete with Metro Headphones................ **$14.00**

Metro Wave Selector
Makes any set highly selective
Completely separates 360 from 400 meters. Adds only one control without changing set. Cabinet, highly polished American Walnut finish **$7.50**

METRO ELECTRICAL CO., Inc.
Manufacturers of Metropolitan Radio Products
69 Goble Street Newark, N. J.

"As Good
As Its Name"

The Battery You Have Been Waiting For

Designed Especially for Radio Work.

11-Plate, 6-Volt—120 Amp. Group. Box is of rubber composition (absolutely leak-proof). With this Victrola style cover, handle and tray, a work of art is achieved in both quality and appearance. PRICE, $25.00 EXPRESS C. O. D. Neat switch embodied in cover, furnished for $1.50 extra.

We also furnish a Radio Junior for smaller sets and automobile batteries, any style and any size. Attractive discounts to agents.

NOBLE BATTERIES
1454 Monadnock Block CHICAGO

Radio Questions Answered

Let the Radio Quiz Book answer all your questions about radio. This book contains 260 questions and answers—detailed descriptions of radio equipment and how to take care of it, and explanations of radio terms, symbols, diagrams, formulæ tables, laws, regulations, etc. It is a book of ready reference **everyone** interested in Radio should have.

Send for the Radio Quiz Book today. For a short time we are selling it for $1.00. Mail letter with $1.00 now!

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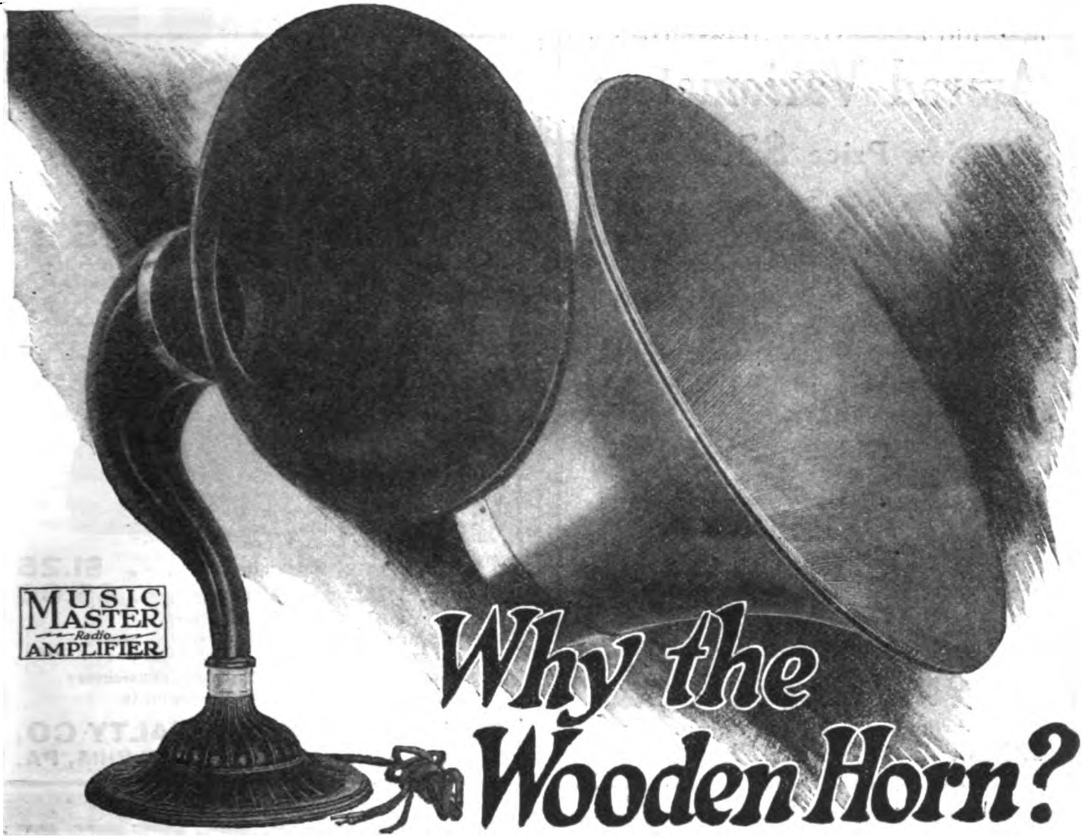
ORIGINAL
NATHANIEL BALDWIN HEADSETS
Type C Complete

SPECIAL PRICE **$11.75**

FREE—with each pair of phones—a $5.00 **Sheltone Loud Speaker.** Phones can be used as head set or on speaker. Both for less than the regular price of the Baldwins. *Cash with order or C.O.D.*

WALTER SCOTT, 10 St. Lukes Place, Montclair, N. J.



Why the Wooden Horn?

A trained ear or a knowledge of music are unnecessary. Anyone can appreciate the Music Master Radio Amplifier. The Wooden Horn gives a sweetened and mellowed tonal quality to the reproduction that imitates the human voice more closely than any other type of amplifier.

The principle was proved by ceaseless research of phonograph experts years before radio was a reality.

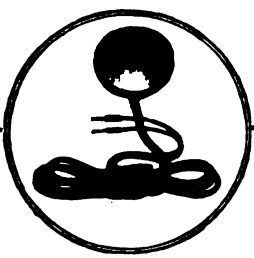
The specially designed reproducing unit found in the art-metal base of the Music Master is attached directly to the cast aluminum gooseneck, which, being a non-vibrating material, carries the mechanically created sound to the wooden horn, by which, beautifully enriched, the message is delivered to the audience.

Complete, ready to attach in place of headphones, no batteries or extra circuit required —

14 inch (Home Model)	$30
21 inch (Concert, Dancing, etc.)	$35

Your dealer will demonstrate the Music Master. There's a thrill in store for you when he does.

JOBBERS DEALERS } A Music Master will be sent to members of the trade with full privilege of return. Complete details and prices on request.



***Geraco Phonograph Attachment* converts your Victrola or Columbia into an efficient loud-speaker.**

Complete . . $10

For sale through Jobbers and Dealers everywhere

GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

CHICAGO
PHILADELPHIA
624-628 Market St.
PITTSBURGH

Write for description and details of complete line.

GERACO
PROVEN RADIO PRODUCTS

"GERACO" on radio apparatus means that it is thoroughly tested and guaranteed.

Amrad Variometers

New Price $3.75

Most efficient variometer on the market.

No dielectric losses, small mounting space required. New automatic machines used in manufacture brings their price within the reach of every Radio Fan. Immediate delivery on all mail orders.

Variometer, less dial, - - - - $3.75
Vario-Coupler, less dial, - - - $3.85

New Loose-Leaf Catalog Now Ready
Write for your copy

LYNN RADIO CO.
Sixth Floor, Consumers Building
220 So. State St. Chicago, Ill.

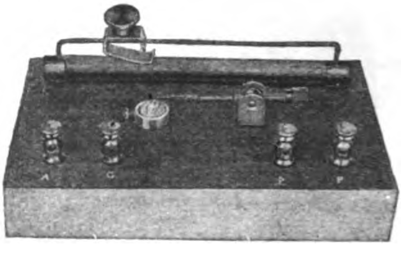
DEPENDABLE TESCO LINE

INSTRUMENT MAKERS SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



TYPE "A" Shown in out) . . $1.25
TYPE "B" De Luxe . . $5.00

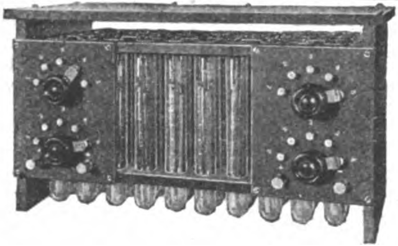
Without Phones or aerial

Sent prepaid upon receipt of express or postal money orders.

Money refunded if not absolutely satisfactory.

Dealers and Jobbers write for discounts.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.



KICO Radio Storage "B" Batteries for EFFICIENT Receiving

1. KICO "B" batteries allow single cell variations by means of switches mounted on panels. (The first in the market with this feature.)
2. Alkaline type.
3. Rechargeable from your 110-volt A. C. line in connection with the rectifier supplied.
4. One charge lasts from three to six months in the detector plate circuit.
5. Neat, efficient and compact.
6. Unlimited life.
7. Your money back if unsatisfied within a 90-day trial.

		(Plain)	(With Panels)
16 cell	22 volt	$6.50	......
24 cell	32 volt	8.00	$12.00
36 cell	48 volt	10.00	14.00
50 cell	68 volt	12.00	17.00
78 cell	100 volt	16.00	21.00
108 cell	145 volt	21.00	26.00

"A" and "B" Battery Literature gladly furnished

KIMLEY ELECTRIC COMPANY
1357 FILLMORE AVENUE BUFFALO, N. Y.

Wave Trap

TRADE MARK
PATENT APPLIED FOR

The Missing Link in RADIO

Stops Interference!

Get rid of the interference that is spoiling your evening concert. By using the "WAVE TRAP" you eliminate it.

It is installed in a minute by changing only one connection, and is indispensable on any receiving set with any type of antenna. It is mounted on a formica panel in a handsome mahogany finished cabinet 6x5x6 and is a high grade instrument throughout.

$8.50 CHARGES PREPAID

Ferbend Electric Co.
21 E. SOUTH WATER, ST.
CHICAGO

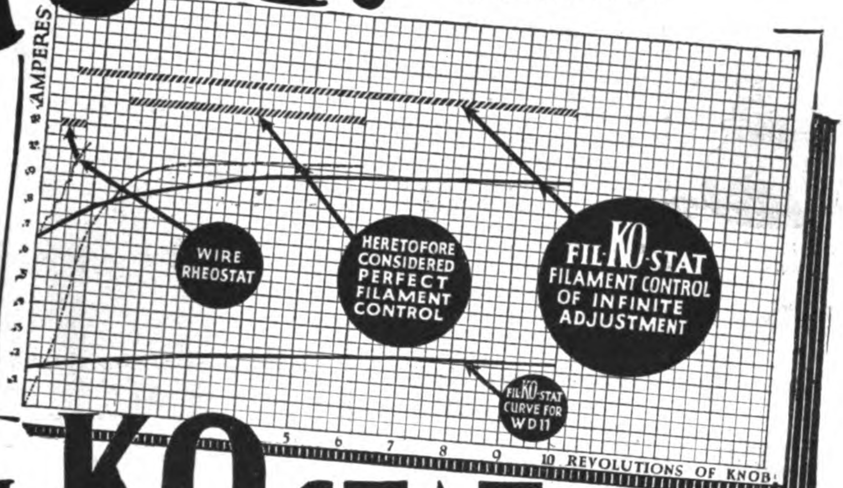
Circular on request.

Proof!

Graphic proof of FIL-KO-STAT superiority as shown here can be had in any laboratory equipped with Bureau of Standards instruments.

Practical proof of FIL-KO-STAT superiority is evident the moment you put FIL-KO-STATS in place of the devices you now use to regulate filament action.

Here's the Comparison of Fine Adjustment Control Range of FIL-KO-STAT With Rheostats and Other Filament Controls Clearly Indicating How FIL-KO-STAT Excels, and Showing Wherein it Permits Perfect and Gradual Current Increase With Infinite Adjustments.



FIL-KO-STAT Best Filament Control

—a step forward in Radio. Not an adaptation of some old method of current control. Not a rheostat. *A FILAMENT CONTROL,* distinctly designed to utilize the great tuning possibilities of the vacuum tube itself. FIL-KO-STAT regulates FILAMENT HEAT. Gives absolute control of ELECTRONIC FLOW, consequently permits FINEST TUNING POSSIBLE. Perfect, gradual increase of filament heat assures longer life to tubes. Fine adjustment of fractional currents makes it ideal for Dry Cell tubes. Infinitesimal control of electronic flow gives a corresponding fine adjustment so very essential in DX tuning.

Say "FIL-KO-STAT" to your dealer today. If he has none in stock *send his name* and your remittance direct to

The filament control KO of infinite adjustment

FIL-KO-STAT

CURRENT INCREASE PERFECT AND GRADUAL

LIKE THE RISING SUN

Trade Mark Registered

Infinitesimal Control
Of Electronic Flow.

Definite Off
Indicating complete "A" Battery disconnection.

Fine Adjustment
Starts where tube *begins* to function.

At Full On
Resistance practically zero.

Absolutely Silent
Non-microphonic free of all noises.

No Current Variations
Resistance constant at any setting.

No Discs to Break or Chip
Resistance element so finely divided further division impossible.

GUARANTEED!

The FIL-KO-STAT is to all purposes "fool proof." Each instrument is packed with the maker's guarantee that it will be replaced if broken within one year.

Manufactured by

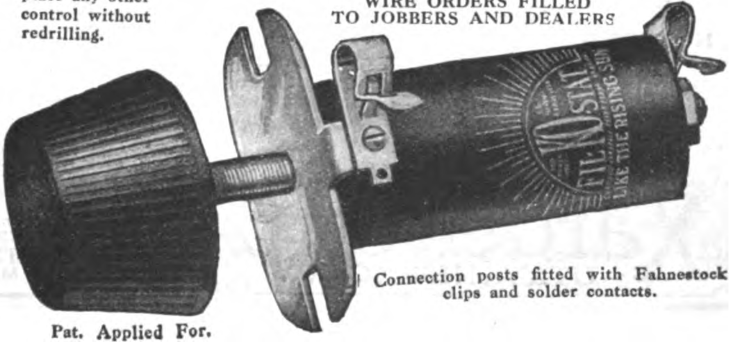
DX INSTRUMENT Co
HARRISBURG PA.

FIL-KO-STAT is compact (exact size shown). Takes little space on panel. Can replace any other control without redrilling.

PRICE
$2.00

SOLE INTERNATIONAL DISTRIBUTORS
RADIO STORES CORPORATION
Dept. P R 218-222 W. 34th St. New York

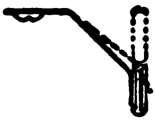
WIRE ORDERS FILLED
TO JOBBERS AND DEALERS



Connection posts fitted with Fahnestock clips and solder contacts.

Pat. Applied For.

Na-ald W.D. 11
No. 411



Na-ald De Luxe
No. 400

It's the contact that counts

The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.

The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each

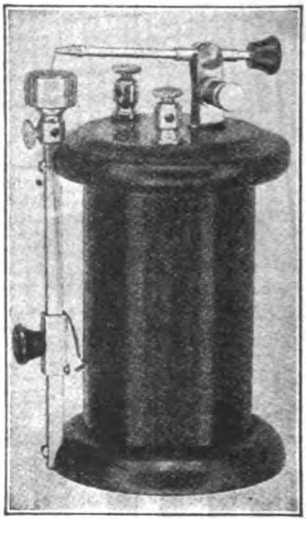
Send stamp for dial, small-space socket, condenser and RF transformer circulars

ALDEN MANUFACTURING CO.
Formerly Alden-Napier Co.
Dept. C 52 Willow Street
Springfield, Mass.

NA-ALD

Crystal Receiving Set

$2.50

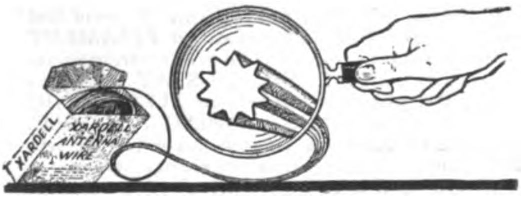


The Ritter Grand Crystal Set is everything that the beginner could wish for. It will tune up to 600 meters and will receive broadcasting stations from 25 to 50 miles. It is made of the best material with mahogany finish, stands six inches high and has the guarantee of high-class receiving qualities with a 100% rating by the Technical Department of Popular Radio.

Free circular of set with instructions on how to direct your aerial sent upon request. Ritter Grand Sets are sold at all J. G. McCrory Stores, F. & W. Grand Stores and at all reliable dealers.

We Invite Jobbers' and Dealers' Inquiries

RITTER RADIO CORPORATION
232 Canal Street New York City



Something Brand New in Antenna Wire

$2.00 PER HUNDRED FEET

That will at once appeal to you. It is different and better than any makeshifts to date, being hard drawn from the finest copper having a corrugated surface with 10 collecting points on its circumference. This gives a greater collective and gathering surface. The result is extreme sensitiveness, and an increase in the range and clearness of any set from the simplest crystal type to the finest V. T. Receiver.

Packed in neat cartons of 100 feet, 200 feet and 500 feet.

Dept. R Postage Paid

Xardell Corp.
UTICA, NEW YORK

PRICES *SMASHED*

Each sale has created new friends and customers, with the result that we now announce drastic reductions in our quality lines. All goods prepaid. Send card for complete list. You'll be surprised. You'll tell your friends. A sample saving follows—

Complete Regenerative Vacuum Tube Set

(Knocked down. Approx. range 1000 miles.)

	Our price	Others
Panel 7" x 12"—Bakelite—drilled	$1.75	$2.50
Cabinet of 3 ply wood to fit above panel	1.50	2.50
Two 3" dials @ 35c each	.70	1.40
16 switch points with nut @ 1c each	.16	.48
4 switch stops with nut @ 1c each	.04	.12
8 nickel plated binding posts @ 3c each	.24	.48
2 switch levers @ 25c each	.50	.90
1 filament rheostat. Highest grade	.65	1.10
1 vario-coupler with 7 multiple, 7 single taps	2.25	4.00
1 23 plate variable condenser. Built right	1.95	3.50
1 tube socket—High grade	.45	.85
1 grid condenser and leak	.20	.35
1 phone condenser	.15	.30
1 support for tube socket	.15	.25
10 feet of spaghetti tubing @ 5c per foot	.50	.84
15 feet copper connecting wire	.15	.30
Blueprints showing details to assemble outfit	.10	.25
	$11.44	$20.12

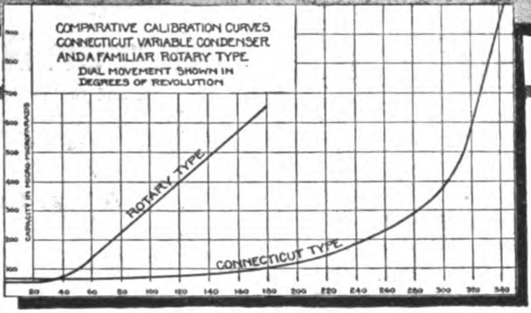
Other articles taken at random from our list are:

Detector tubes—Cunningham—New. NOT rebuilt	$4.25	$5.00
Amplifying tubes—Cunningham—New. NOT rebuilt	5.50	6.50
Transformer—Audio frequency, United	2.95	4.50
Variometer — Hardwood Stators 4¾" square. Assembled Workrite type	2.45	4.00
Frost Fones ......2000 ohms	3.95	5.00
Dictograph ......3000 ohms	6.50	8.00
Stromberg Carlson..3000 ohms	5.95	7.50
Murdock ....3000 ohms	4.75	5.50
Holtzer Cabot ....2200 ohms	6.25	8.00
Manhattan ....2000 ohms	4.95	6.00
Manhattan ....3000 ohms	5.50	7.00
Two stage amplifier—Knocked down. Cabinet and drilled panel	12.95	23.50
Blueprints giving detail of two stage amplifier	.10	.25

Send for full list today or order from above. Goods sold subject to return for rebate or exchange. YOU SIMPLY MUST BE PLEASED.

RADIO PARTS MANUFACTURING CO.
Dept. "P" 2150 Montclair Detroit, Mich.

CONNECTICUT RADIO



This Tells the Tale

Which Variable Condenser Is Best for Your Set

Up to 400 micro-microfarads—the extreme capacity ordinarily employed in designing circuits for short wave lengths—the CONNECTICUT Variable Condenser has over 300 degrees of dial movement.

This gives a working range two and one-half times greater than that of the plate type instrument. Dial movement makes such slight capacity change that most accurate settings are possible.

These features together with the neatness of its design, the compactness of its construction, the lengths of its scale (350° against 180°), the low waste of signal energy, the impossibility of short circuiting, and the way in which it is shielded from outside fields, all combine to give the CONNECTICUT Variable Condenser an immense advantage over the ordinary plate type of instrument, and make it the most practical improvement you could adopt for your set.

Panel Type, J-108
$5.50

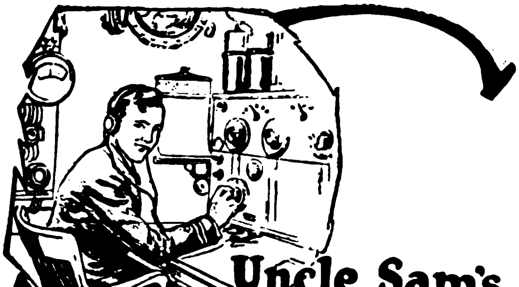
Portable Type, J-107
$6.50

Booklet 100-F describing CONNECTICUT *Variable Condensers in detail will be sent upon request*

RADIO DIVISION

CONNECTICUT TELEPHONE & ELECTRIC COMPANY

MERIDEN CONNECTICUT



Uncle Sam's Choice!

Eight years of strenuous service in the U. S. Navy and Signal Corps have proved Bakelite-Dilecto (xx grade) supreme for radio insulation.

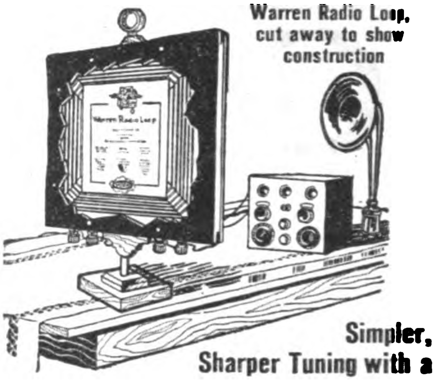
bakelite-dilecto!!

(A Laminated Phenolic Condensation Product)

Makes the *perfect* radio panel.
Tough, durable and super-resistant.
Finished a smart, sleek black. Cannot warp. Machines readily.
Electrical men can get B D X X cut and drilled to your specifications.

THE CONTINENTAL FIBRE CO.
FACTORY: NEWARK, DELAWARE
Dealer Service From:
New York, 233 Broadway
Chicago, 332 S. Michigan Ave.
Pittsburgh, 301 Fifth Ave.
San Francisco, 75 Fremont St.
Los Angeles, 411 S. Main St.
Seattle, 95 Connecticut St.

X X



Warren Radio Loop, cut away to show construction
Warren Radio Loop

Simpler, Sharper Tuning with a

Warren Radio Loop

AERIAL and tuning device all in one. Tunes not only to wave *length* but to wave *direction*. An aid to selection. Eliminates atmospherics. All enclosed—dust and damp proof, fool-proof and surprisingly compact, neat and durable. Write today for Bulletin I-102, containing hookups.

A Type for Every Set
at the Best Dealers

Type-A-787 (300-700 meters) 6 inches square—non-directional.....$10
Type-A-7886 (175-1000 meters) 6 inches square—non-directional...$12
Type-B-2587 (300-700 meters) 18 inches square—directional........$20
Type-BL-2590 (200-18,000 meters) with honeycomb coil. 18 inches square—directional.....................................$25

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO. Dept. F. **Asbury Park, N. J.**

A Chi-Rad handbook for this 'Ad' and 10¢

Because of the astonishing number of requests for Chi-Rad's latest Handbook-Catalog, we are forced from this date on to make a small wrapping and mailing charge.

In this Chi-Rad Handbook are 48 pages of valuable information for every radio fan. It includes the following:

1. Technical discussions of standard radio apparatus and equipment.
2. Complete instructions, including diagrams, circuits, and illustrations on "**How to Build a Reinartz Receiver.**"
3. Radio definitions, codes, wire tables, etc.

Just wrap a dime up in this ad and mail it to us today. Requests for books will be filled in the order in which we receive them.

Chicago Radio Apparatus Co.
415 S. Dearborn St.,
Chicago

P. R.

Make Your Crystal Set 100% Efficient by Using

MPM

'Million Point Mineral'

The WORLD'S GREATEST RADIO CRYSTAL

THE discovery of M. P. M. has revolutionized the possibilities of ordinary crystal sets. Concerts have been clearly heard over 600 miles. M. P. M. is super-sensitive—reproducing from every point on its surface. It increases audibility as well as radius, and makes the purchase of an extensive tube set unnecessary.

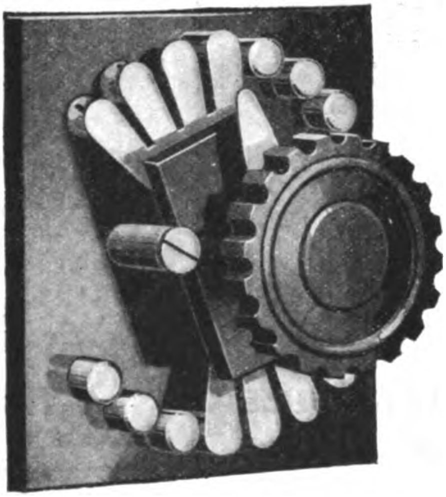
Send 25c and name of your RadioDealer for a sample M. P. M. Crystal—concert-tested and guaranteed. Address Dept. PR.

M. P. M. SALES COMPANY
247 S. Central Ave. Los Angeles, Calif.

FIL-FONE SWITCH

One Installation One Movement for all Filament Control

No Jacks No Plugs No Separate Switches



Price, $3.00

Design and Circuit Connections Protected by Patents Pending

The ***Fil-Fone Switch*** is the latest addition to our remarkably complete line of Radio Products. Designed for convenience and elimination of surplus parts. Gives the operator perfect control of his tubes without noise or inconvenience of plugging in phones from one stage to another.

The ***Fil-Fone Switch*** automatically lights the filaments and connects the "B" Battery and telephones to either Detector, first stage of amplification or second stage of amplification as desired, with a positive and progressive operation. It has an "OFF" position which disconnects the filament battery, "B" battery and phones from the set.

This method of filament control is sure to be universally adopted in set building because of its simplicity, convenience and saving of expense. Sold ready for mounting, with complete wiring diagram.

Send for Free Descriptive Circular, F. F. S. No. 1

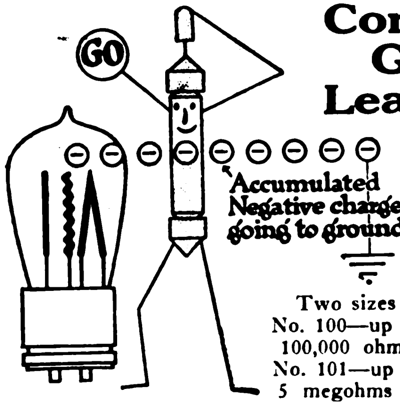
(Complete catalog of Radio Parts with useful Radio information sent on receipt of six cents in stamps for mailing.)

The A-C Electrical Manufacturing Co.

DAYTON OHIO

Makers of Electrical Devices for Over 20 Years

Controls Grid Leakage


GO
Accumulated Negative charges going to ground

Two sizes
No. 100—up to 100,000 ohms
No. 101—up to 5 megohms

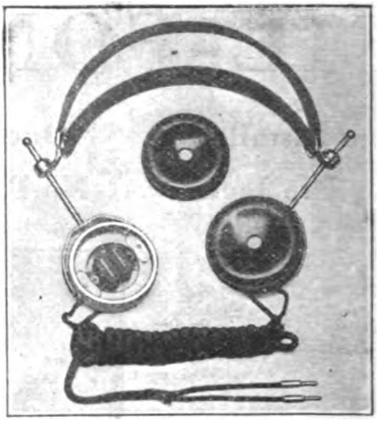
If the negative charges march too slow or too fast from the grid, their "footsteps" cause a "sizzling" in the phones. Control this leakage in your set with the simple plunger-controlled DURHAM Variables. Buy from your dealer.

Durham & Co., 1936 Market St., Philadelphia

DURHAM Variables High Resistance

RADIO

HEADPHONES



SENT ON APPROVAL

$8 LIST PRICE $8

2,200 OHMS LOUD AND
LIGHT WEIGHT CLEAR

Dealers May Send $3.20 for Sample

Add 20 cents for postage
MONEY BACK GUARANTEE

FRENCH MFG. CO., Seymour, Conn.

Amplification Perfection

with all Standard Tubes

An Audio Transformer will give the same results with all tubes which are alike in A. C. Impedance and Amplification Factor.

WD-11
UV-199
UV-201-A
UV-201
C-301

These tubes all have nearly the same A. C. Impedance.

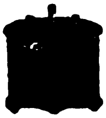
The AMERTRAN

—universally acknowledged the greatest of all amplifiers, gives the same wonderful amplification curve with WD-11 dry cell tubes as with UV-201 Radiotrons.

PRICE $7.

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

RADIO SPECIALS



You will get better results from Greenleaf Condensers. High-grade, perfectly constructed. Greatly reduced prices for limited time only.

3	Plate	Variable	Condenser	$ .90
11	"	"	"	1.35
21	"	"	"	1.55
43	"	"	"	2.25

Send Order at Once. Cash with Order
(FREE Radio Broadcasting List)

GREENLEAF RADIO CO., Dept. P-21
34 Merchants Row, Boston, Mass.

RADIO-PATENTS

Procured. Send sketch or model today for examination, prompt report and advice. No charge for preliminary advice. Write for free Booklet and blank form on which to disclose your idea. Highest references. Promptness assured.

CLARENCE A. O'BRIEN
Registered Patent Lawyer 1036 Southern Building, Washington, D. C.

RADIO TUBES REPAIRED

We solicit your burned out 6-Volt Radio Bulbs for repairs.
Our work is guaranteed.

REFILLED TUBES IN STOCK

Detectors....$2.75 Amplifiers....$3.00

RADIO TUBE LABORATORIES, INC.,
776 BROAD STREET NEWARK, N. J., U. S. A.

Radio
Wireless Telephone
Wireless Telegraph
Equipment
Montgomery Ward & Co.
Chicago Fort Worth Kansas City Portland, Ore. Saint Paul
Map of Broadcasting Stations
Complete Selection of Parts
Dictionary of Radio Terms
Large Selection of Outfits
Study These Diagrams and Definitions
Antennae Aerial
16.00

Radio Catalogue FREE

One copy of this complete Catalogue of Radio Outfits, parts, Dictionary of Radio Terms, Instruction Book, and Guide to Successful Radio Work—one copy is yours Free.

Simply write us a post card and we will mail the complete book to you Free, by return mail.

It quotes the lowest prices, amazingly low prices on everything for the expert and the amateur. Every improved part, the most up-to-date outfits, everything that is needed of the most modern type—at the lowest possible prices.

It gives a list of broadcasting stations, and gives much information about radio construction and operation. Every one interested in Radio needs this complete catalogue and book of instruction.

Why Pay Higher Prices?

Montgomery Ward & Co. has for fifty years dealt on a Money-Back basis, absolutely guaranteeing everything they sell. With quality absolutely assured, why pay higher prices elsewhere? Write today for this Free Radio Book and see for yourself the Saving it will bring you.

One copy is yours Free. You need only write us a post card.

Write to the house nearest you.
ADDRESS DEPARTMENT 38-R

Chicago Kansas City St. Paul
Fort Worth Portland, Ore.

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

MELCO SUPREME

Favored by Thousands of Radio Fans

PRICE **$125**

THE "Melco Supreme" Radio Frequency Amplifying Receiver can be used with indoor or outdoor aerial, loop or lighting plug. Operation is simplicity itself. Covers all broadcasting ranges from 175 to 500 meters wave length. A new departure in radio—non-reflex, non-regenerative, tuned radio-frequency. Amplification is extremely high per stage without the slightest loss of tone quality. Neither distorts the wave nor interferes with other members of the radio audience. Single tuning adjustments assure greatest degree of program selectivity and most satisfactory long distance receiving is permitted by this new system.

We also manufacture a complete line of standard parts. Write to any of our offices listed below for catalogs 1001 and 1002 illustrating and describing all our products.

MORTIMER RADIO CORP., 114-116 Fulton Street, New York

Huntington, W. Va., 1028 Fourth Ave.; **Philadelphia, Pa.**, 636 Victory Bldg.; **Pittsburgh, Pa.**, 704 Granite Bldg.; **Los Angeles**, 337 South Western Ave.; **Atlanta, Ga.**, Flatiron Bldg.; **San Francisco, Cal.**, 709 Mission Street; **St. Louis, Mo.**, 13 South 4th St. **Exclusive Canadian Representative, Scott Bros., Ltd., 332 St. Catharines St. West, Montreal, Que.**

RUSONITE

CRYSTAL RECTIFIER

MULTIPOINT

(Patent Pending)

A Synthetic CRYSTAL DETECTOR sensitive over its entire surface

Eliminates all detector troubles. Extraordinary clearness and volume. Endorsed by radio experts and press. Sold in sealed packages only. Join the ever-increasing Rusonite fans.

Price, postpaid, mounted Sensitiveness guaranteed 50c

RUSONITE CATWHISKER
14-Karat Gold Multiple contact. Supersensitive 25c

Order from your dealer or direct from us.

Rusonite Products Corp., Dept. "P," 15 Park Row, N .Y.

NOVO
"B" BATTERIES

NOISELESS

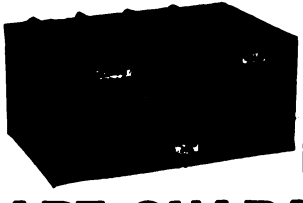
DEPENDABLE

NOTE THE INSULATED BINDING POSTS AND 7IN. WIRE CONNECTOR

NOVO M'F'G CO.

424 W. 33rd ST.
NEW YORK

531 SO. DEARBORN ST.
CHICAGO



DELFELCO RADIO B BATTERIES
ARE GUARANTEED

Small 22½V	$2.00
Small 45V	4.00
Large 22½V	3.00
Large 45V	5.50

Postage Paid

DELFELCO BATTERY CORP.

11 MEETING STREET PAWTUCKET, R. I.

FREE
CATALOGUE

Make D X Records With D X Supplies

This Catalogue should be called "Recipes for Long Distance." It was written to help amateurs pull in the most distant stations.

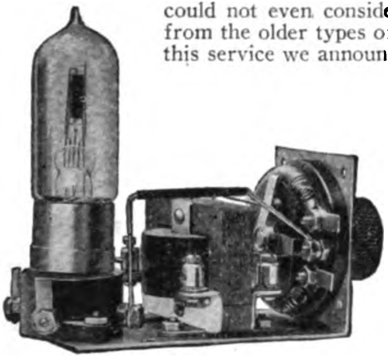
To Get Your Copy Write Department 16

D-X Radio Company

123 Liberty St. New York City

NO MORE STORAGE BATTERIES

The new WD-11 vacuum tubes requiring but a single dry cell to heat the filament have opened up a whole new field in radio. Sets are now brought within the reach of vast numbers who could not even consider them before. These new tubes differ in construction from the older types of tubes and require different associated instruments. For this service we announce the following:



TYPE 300-A AMPLIFIER UNIT

A compact unit consisting of our Type 231-A Amplifying Transformer, Type 225, Filament Rheostat and Type 282 WD-11 Tube Socket mounted on a nickel finish brass mounting. These parts are all wired ready for the external connections. The mounting is so designed that the unit may be used on a table or mounted behind a panel with only the rheostat knob projecting.

Price $7.50

TYPE 300-B AMPLIFIER UNIT

This unit is similar to the 300-A unit except that it is equipped with standard socket for UV-201 tubes.

Price $8.00

TYPE 282 WD-11 TUBE SOCKET

A socket of molded bakelite arranged with positive contact springs to take the WD-11 tubes. This is a socket in itself, not an adapter.

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TYPE 255 RHEOSTAT

A rheostat of molded bakelite, not a substitute, for panel or table mounting, smooth in operation and attractive in appearance. Resistance 6 ohms, with current carrying capacity of 1.25 amperes. May also be supplied with a resistance of 3.5 ohms and a current carrying capacity of 2.5 amperes.

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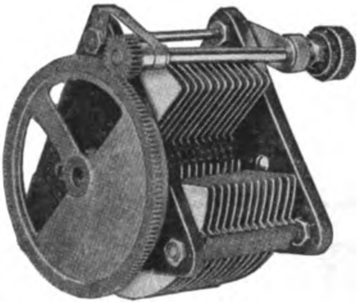

TYPE 231-A AMPLIFYING TRANSFORMER

Remember that this transformer is particularly suited to the WD-11 as well as to the UV-201 and 201-A tubes.

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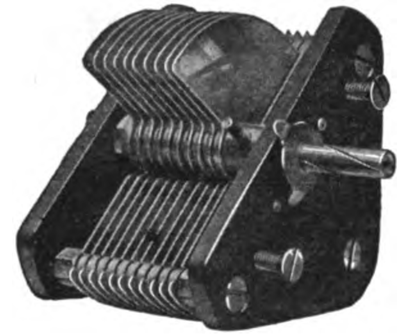

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WRITE FOR DESCRIPTIVE BULLETIN P-4

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"How I Located My Trouble"

A Massachusetts radio enthusiast tells of a happy discovery that finally solved his difficulties.

"I COULDN'T figure out what was wrong with my radio set," states a Fitchburg business man whose experience is interesting because it shows how one simple little adjustment will sometimes make such an amazing improvement in results.

"I had erected my antenna in just the right way, had connected up my different instruments with the greatest care, had added improvements that were designed to bring my apparatus to the highest possible perfection," he continues.

"I spent a good many hours talking over my problems with dealers and experts. I followed one suggestion after another. But still the same old trouble!"

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"In spite of all my efforts, when I wanted to hear some particularly interesting broadcasting program, other stations kept breaking in; I found difficulty in getting long distance points; and intermittent squeals, whistles and howls would persist, no matter how I tuned or adjusted my dials.

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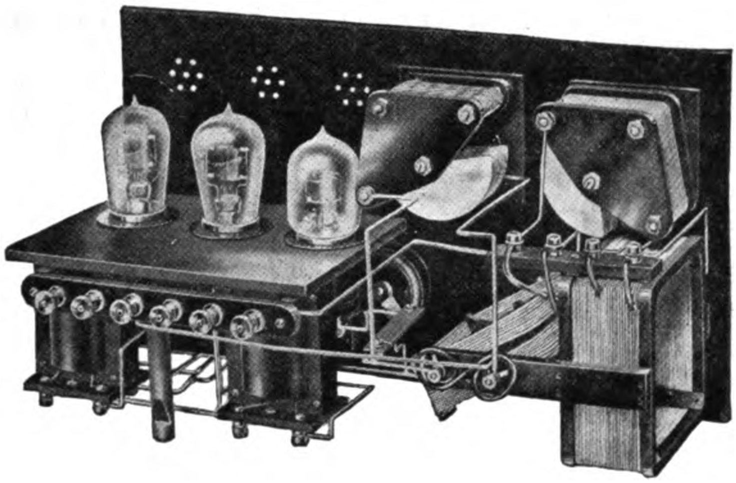

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During the past month more unsolicited subscriptions to POPULAR RADIO have been sent in than during any other single month of POPULAR RADIO'S history. There are thousands of other radio enthusiasts who would be mighty glad to invest only a two-dollar bill in a year's subscription to POPULAR RADIO—a 12 months' service that brings radio instruction, new hook-ups, general articles and radio short-cuts invaluable to every enthusiast. Send in their subscriptions and make your own selection from this heap of radio equipment. It won't cost you a penny.

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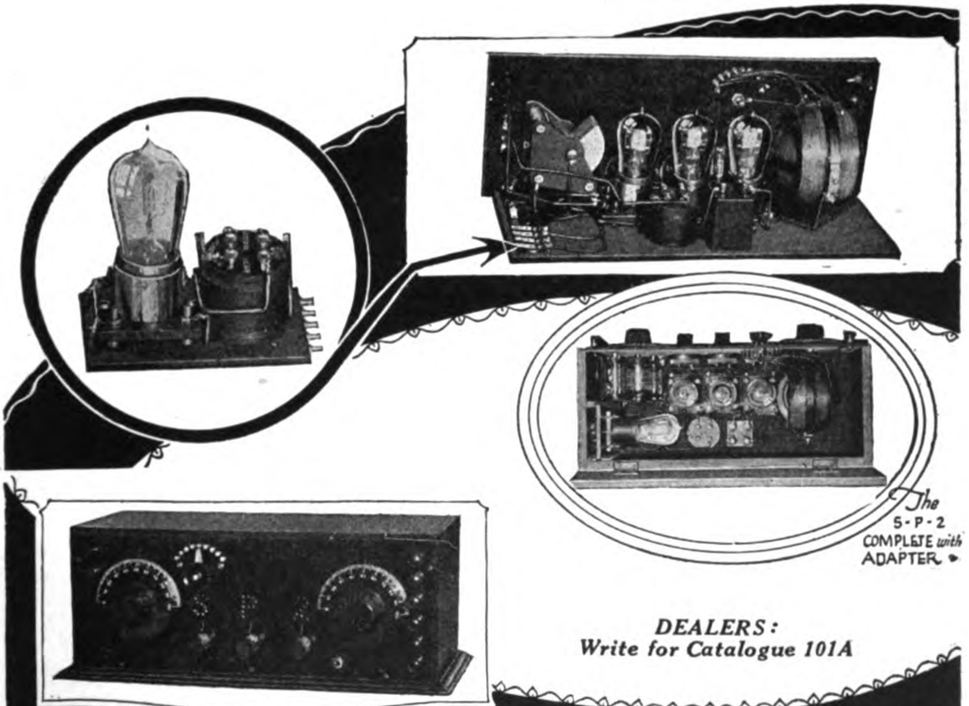

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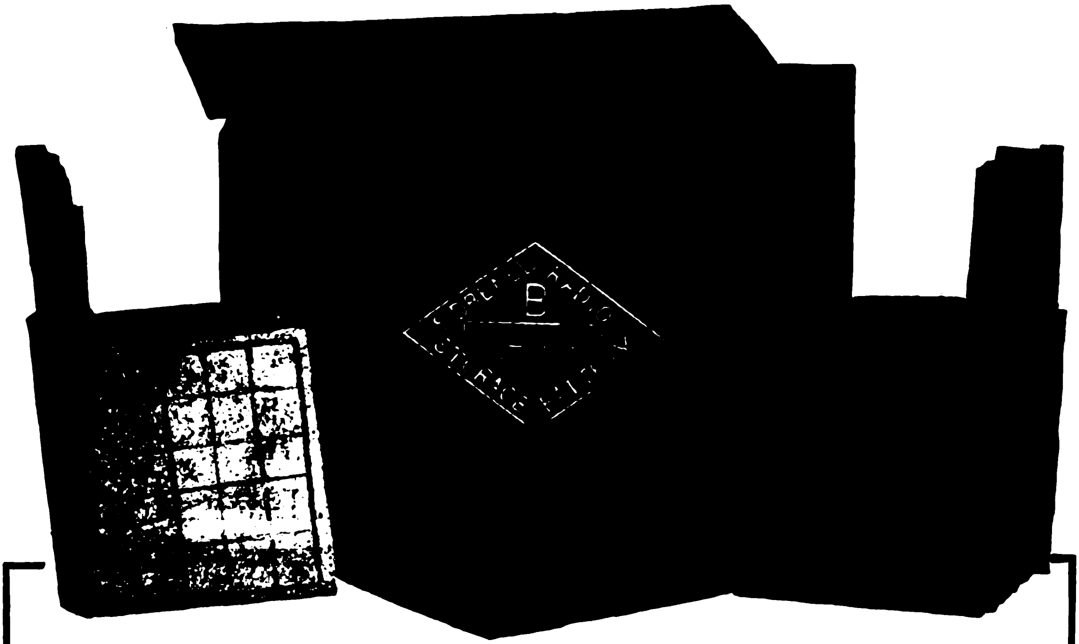

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THE invention is chiefly in the composition of the plates and construction of the battery boxes, which are of hard rubber moulded into ten compartments. Size 2½ x 3 x 4½ per unit. Illustration shows its very sound and rigid construction.

The plates are especially treated with a newly discovered chemical that eliminates howling and screeching, otherwise known as electrical static generated in every known type of dry "B" Battery. A single charge will last approximately six months. Recharged in a few hours to its original full capacity. For less than ½ cent the battery is thus ready for another six months' use.

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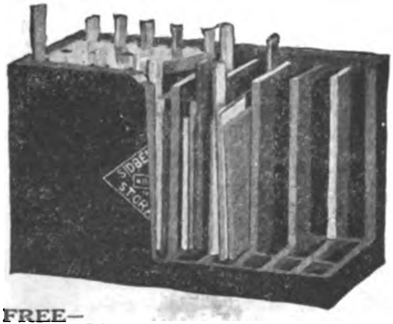

Rectifier for A. C. current 35c

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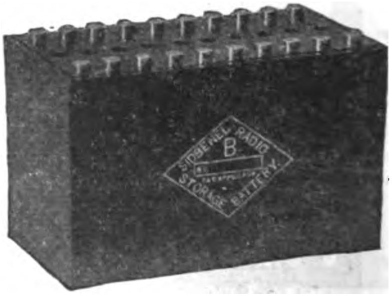

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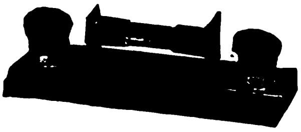
NOTICE—The contest which we announced in the March *Popular Radio* is open only to those who were owners of Teleradio Phones on or before February 15, 1923. The contest will close on April 1, 1923.



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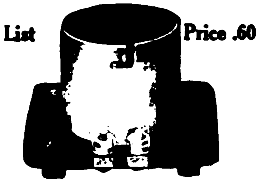

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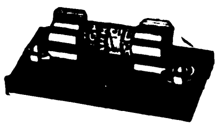

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A perfect battery for all ignition purposes —delivers a hot dependable spark every time.

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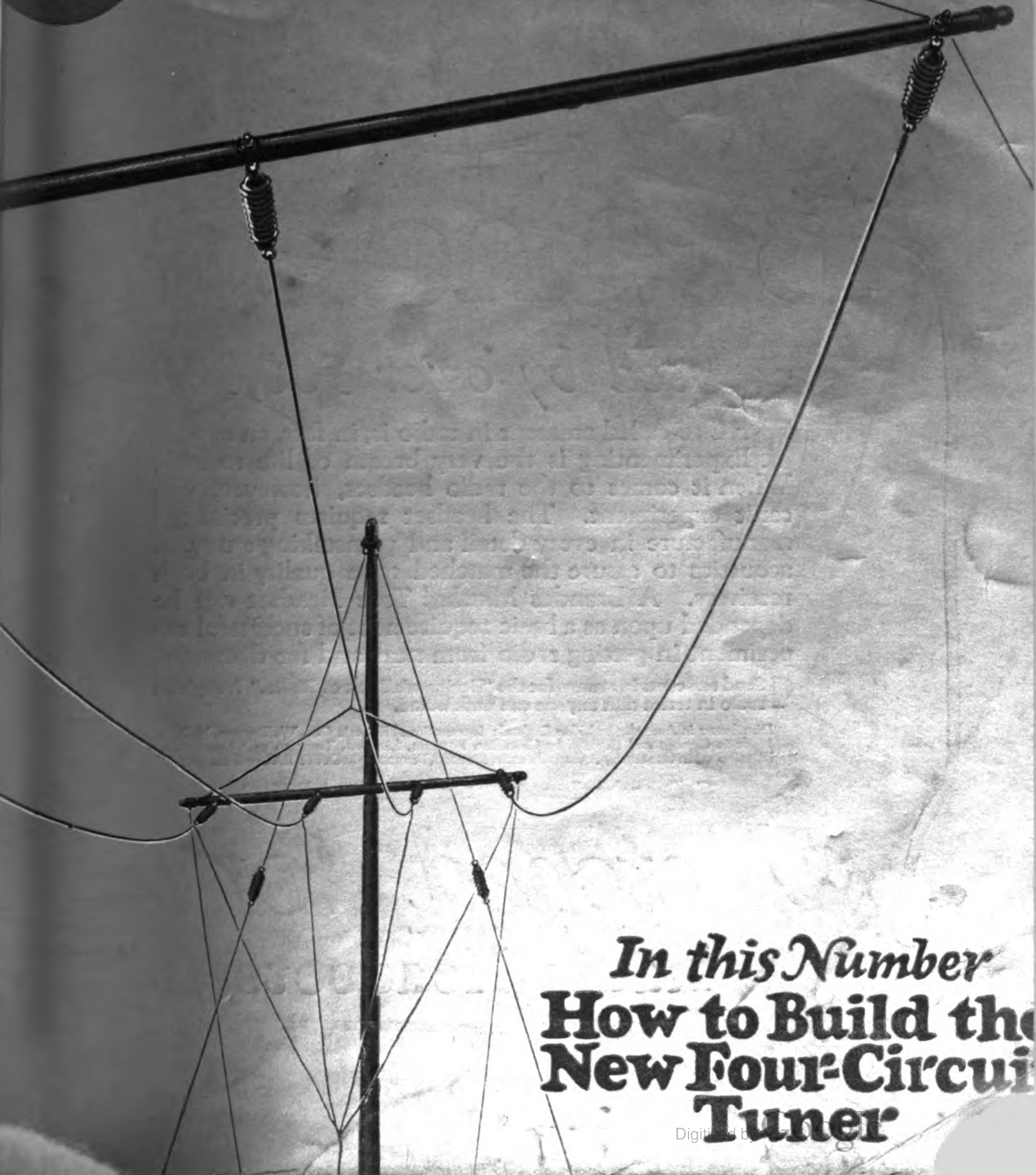

In this Number

How to Build th
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Tuner

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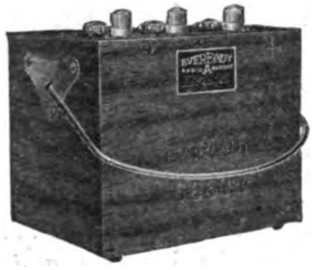

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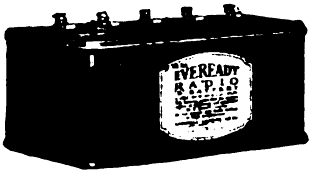
For Dry Cell Tubes use EVEREADY Dry Cell Radio "A" Batteries



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Atlanta Chicago Cleveland Kansas City San Francisco

Insist on Eveready—
Accept no Substitute

EVEREADY
Radio Batteries
—they last longer

POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

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Grebe Receiver

can come up to his expectations.

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A PAGE WITH THE EDITOR

EACH TECHNICAL QUESTION THAT WE ANSWER COSTS US 88 CENTS

Here is a picture of our Technical Editor, Laurence M. Cockaday (left) and his newest assistant, Albert G. Craig, studying some of the hundreds of inquiries that pour in from our subscribers. If YOUR *inquiry is somewhere in this pile, you will now understand why it is not answered by return mail.* BUT IT WILL BE ANSWERED!

WITH this issue POPULAR RADIO celebrates its first birthday.

* * *

DURING its eventful first year it has grown in bulk exactly 100 percent. Its advertising patronage has grown 785 percent. And its circulation has grown from nothing to somewhere about 100,000 copies a month—which represents a percentage so high that the Editor does not know exactly how to compute it!

* * *

GRATIFYING as is this remarkable evidence of material success—a success that has been made possible only by the friendly advice and co-operation of radio fans throughout the country—nevertheless the Editor is equally if not more concerned with the position of authority which POPULAR RADIO has attained in the world of science. How do the world's greatest scientists look upon us?

* * *

THE most conclusive answer may be found in POPULAR RADIO's list of contributors—probably the most distinguished group of scientists ever assembled in any one magazine in so short a period. The list speaks for itself:

Sir Oliver Lodge, Guglielmo Marconi, Prof. James A. Fleming, Dr. Lee De Forest, General George O. Squier, Dr. Charles P. Steinmetz, Dr. Elihu Thomson, Dr. Henry Smith Williams, Prof. J. H. Morecroft, John V. L. Hogan, Paul Godley, Laurence M. Cockaday, Hudson Maxim, Dr. E. E. Free, Hiram P. Maxim, Nikola Tesla, Edwin H. Armstrong, Dr. Henry D. Hubbard, Dr. E. E. Slosson, Waldemar Kaempffert, John Hays Hammond, Jr.—to mention those that first come to mind.

And among its contributors of non-scientific articles are numbered authors whose names are known to magazine readers throughout the world.

* * *

To its rapidly growing number of subscribers, contributors and advertisers, whose essentially practical endorsement of the magazine has made its success possible, the Editor extends not merely thanks but congratulations.

* * *

AGAIN the flood of questions submitted to our Technical Editor by our readers is getting beyond control. Gratifying as this evidence is of the value of our Technical Editor's advice, nevertheless the accumulating mail is presenting a serious problem. How can the Technical Editor answer it all?

* * *

WE are answering *this* question in part by adding to our technical staff another radio expert, Mr. Albert G. Craig, with whom many of our readers are already acquainted. Mr. Craig graduated from Purdue University as an electrical engineer, and has had wide experience in important research laboratories. He is a member of the A. I. E. E., and a contributor to radio textbooks here and abroad.

* * *

Don't put aside your radio set just because summer is near! In the next issue we will tell you how to use your set on your vacation—and give you specific, practical information on the subject, together with actual hook-up diagrams and photographs of successful installations.

Kendall Banning

Editor, POPULAR RADIO

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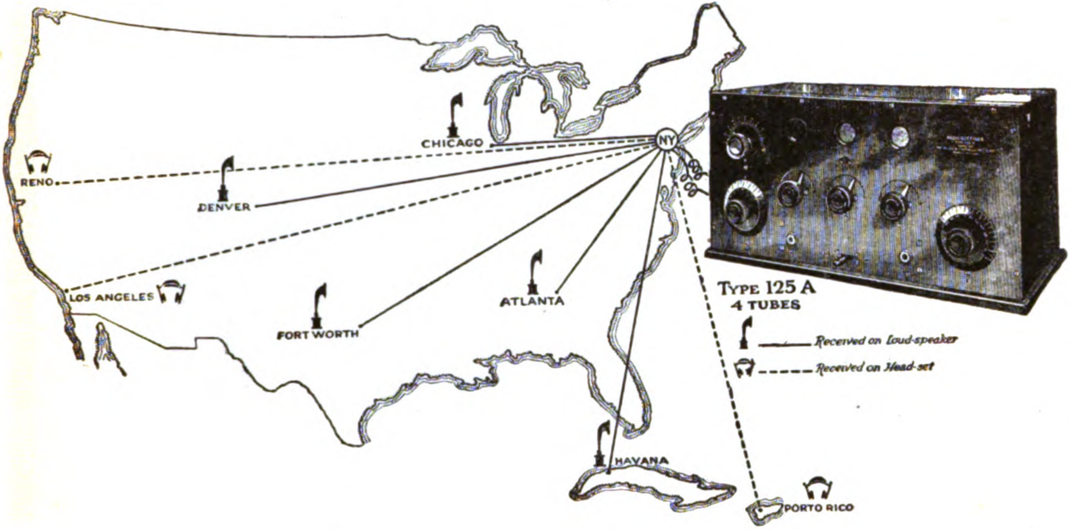

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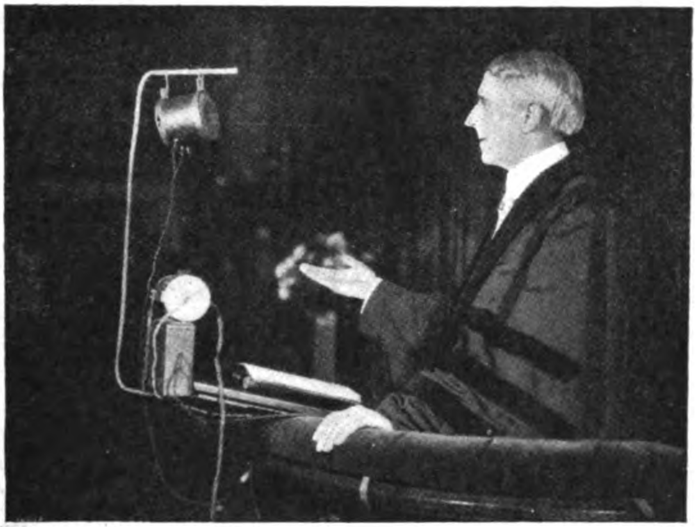


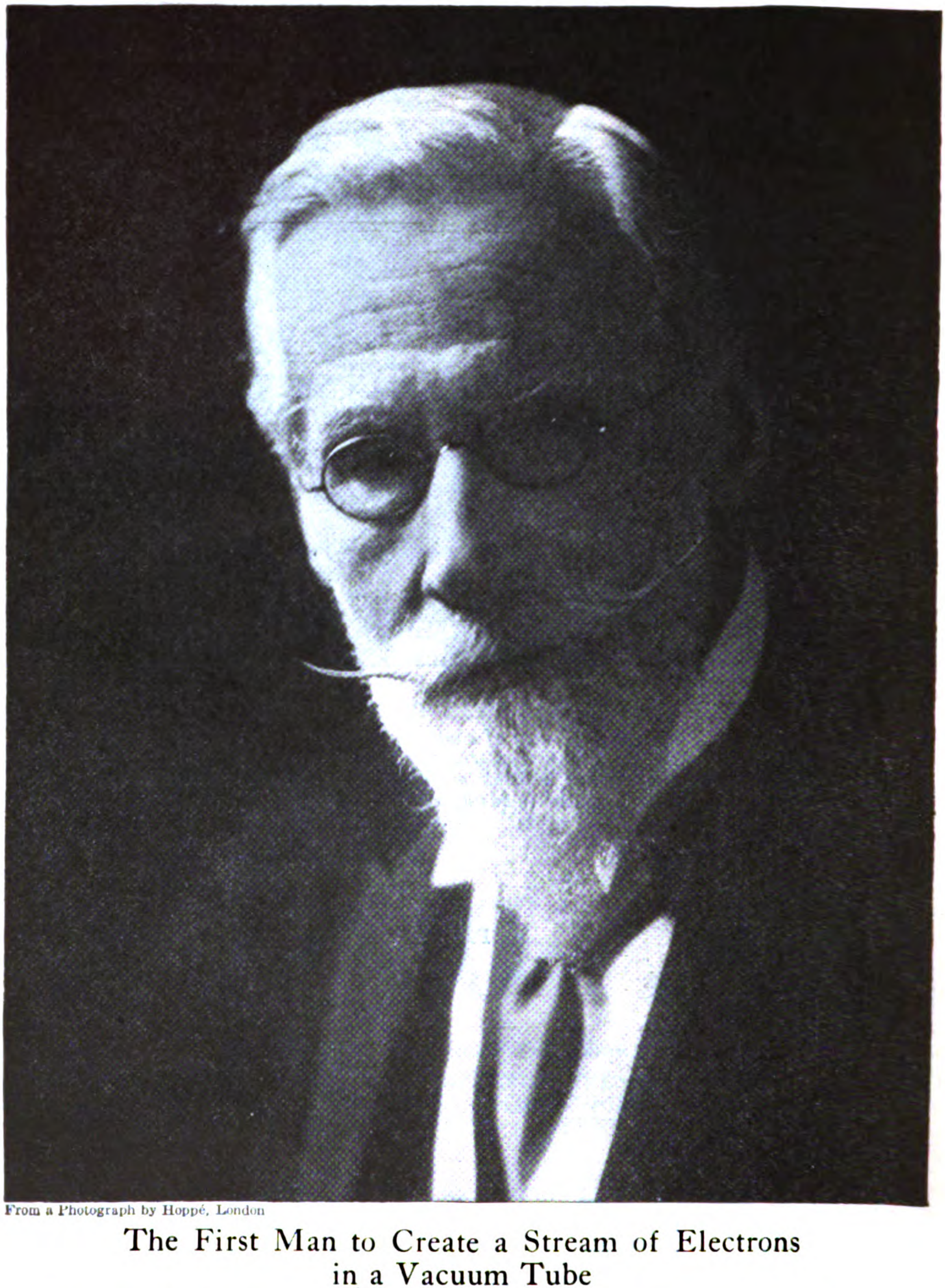
Underwood & Underwood

RADIO WILL HELP THE CHURCH

"THERE *is, I know, a good deal of controversy as to just what effect radio is having or will have on church attendance. Judging from such letters as come to my desk from our invisible audience, I am led to believe that the effect will be favorable rather than unfavorable to church attendance.*"

A. Edwin Keigwin

PASTOR, WEST END CHURCH, NEW YORK



From a Photograph by Hoppé, London

The First Man to Create a Stream of Electrons in a Vacuum Tube

While Sir William Crookes *was experimenting with his own invention, the Crookes tube, in 1876 he noticed for the first time a glow discharge that "flew away from the cathode in radial lines." His investigations of this phenomenon led to the discovery of the X-ray by Roëntgen in 1895 and ultimately to the acceptance of the electron theory by scientists throughout the world.*

Popular Radio

VOLUME III MAY, 1923 NUMBER 5

Thoughts *that* Shake the Ether

Radio signals never come to an end. Scientifically, they go on forever. So does every physical and mental impulse that we create. Ether makes us, in fact, immortal—as this article by a distinguished inventor points out with startling vividness.

By HUDSON MAXIM, DS.C., LL.D.

THE most marvelous and the most mysterious thing in the universe, so far as man can conceive it, is the ether. From the ether all the worlds have been quarried and from the ether all life has sprung. The commandeering of the ether in the radio service is a thing so wonderful and so masterful as to make the ghosts gaze.

If, in telephoning by wireless from New York to San Francisco, the voice should travel at merely the speed of sound, more than four hours would be required for the first word to reach the ear of the listener; whereas, by radio, the voice is transmitted at the speed of light, (186,000 miles a second) so that there is no appreciable lapse of time in the transmission of the voice to any distance on the earth's surface.

If, however, it were possible to establish radio communication with the nearest fixed star, *Alpha Centauri,* it would take four years, even by radio speech, to cross the gap. With merely the speed of sound, it would take four million years for speech to reach the Centaur.

If one of our amateurs should pick up a radio message sent out to us from some planet that is circling a sun on the far frontiers of the Milky Way, he would know that the sender of the message lived and died more than twenty-five thousand years ago, and that the message had been on the way all that time—and this, too, coming at the speed of light. For the light by which we see such a star left there 25,000 years ago, when the Cro-Magnons inhabited Europe, along with the saber-toothed tiger, the hairy mammoth, and the wooly rhinoceros. From that time twenty thousand years had to pass before Egypt appeared on the far horizon of history. Babylon, Greece, Rome, also rose and fell during the five thousand years more before the message would reach the inhabitants of the earth, and also before the inhabitants of the earth would have the skill and knowledge to receive the message, and, perhaps, to translate it.

Time-honored sound is slow-paced compared with the speed of ether waves; still sound, too, has its marvels.

For example, on a quiet summer evening, one with keen ears can hear a katydid half a mile away. This means that that little insect, by rubbing its legs and wings together, is able to shake a cubic mile of air.

How much does a cubic mile of air weigh? Does it weigh a hundred pounds, a thousand pounds, or several tons? What do you think?

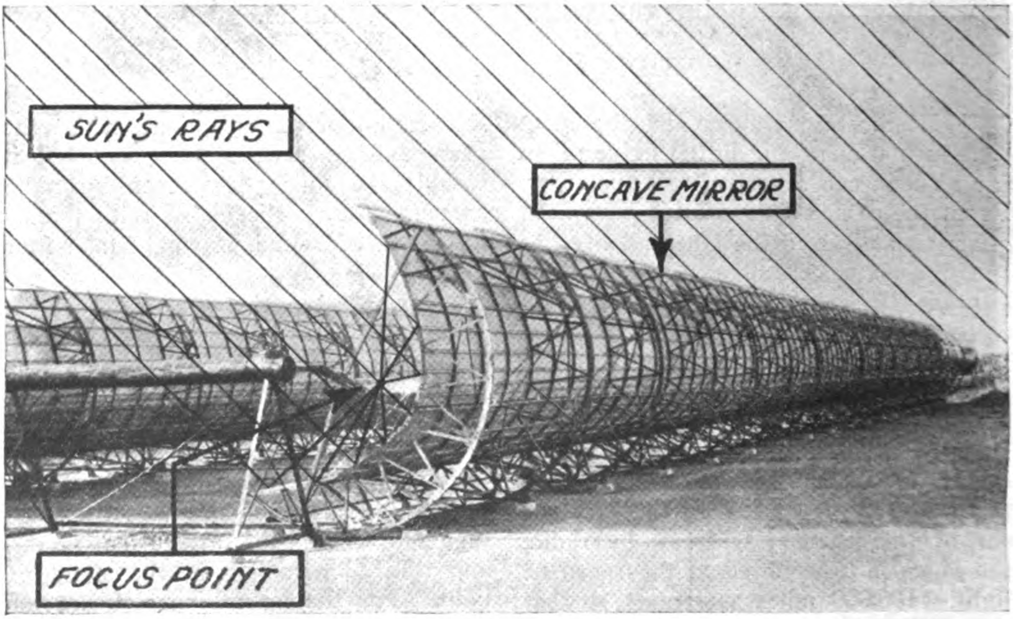
A cubic mile of air weighs more than six million tons—and that little katydid sets all that six million tons of air in rapid vibration!

A little chick-a-dee with its song thinks nothing of shaking up six million tons of air!

The ether about us is in a constant state of vibration of inconceivable intensity, but the ether of space fills up the gaps between the atoms of our body and so the vibrations pass through the space we occupy as freely as though it were a vacuum and, consequently, we are unconscious of the presence of them.

It would require a solid steel cable with a diameter equal to our earth, and having a tensile strength of 80,000 pounds to the square inch of cross section, to tether the earth to the sun, as the ether does by the force of gravitation.

Dr. Charles F. Brush, the great electrical inventor, of Cleveland, Ohio, has made some important discoveries upon the subject of gravitation. He has made some determinations, for example, which



Brown Bros.

HOW HEAT FROM THE SUN IS MADE TO RUN AN ENGINE

By means of these massive concave mirrors, the solar rays are concentrated upon a pipe that contains water; the heat thus obtained furnishes sufficient power to operate a low-compression engine. The "furnace" of its power plant is, in reality 96,000,000 miles away!

Brown Bros.

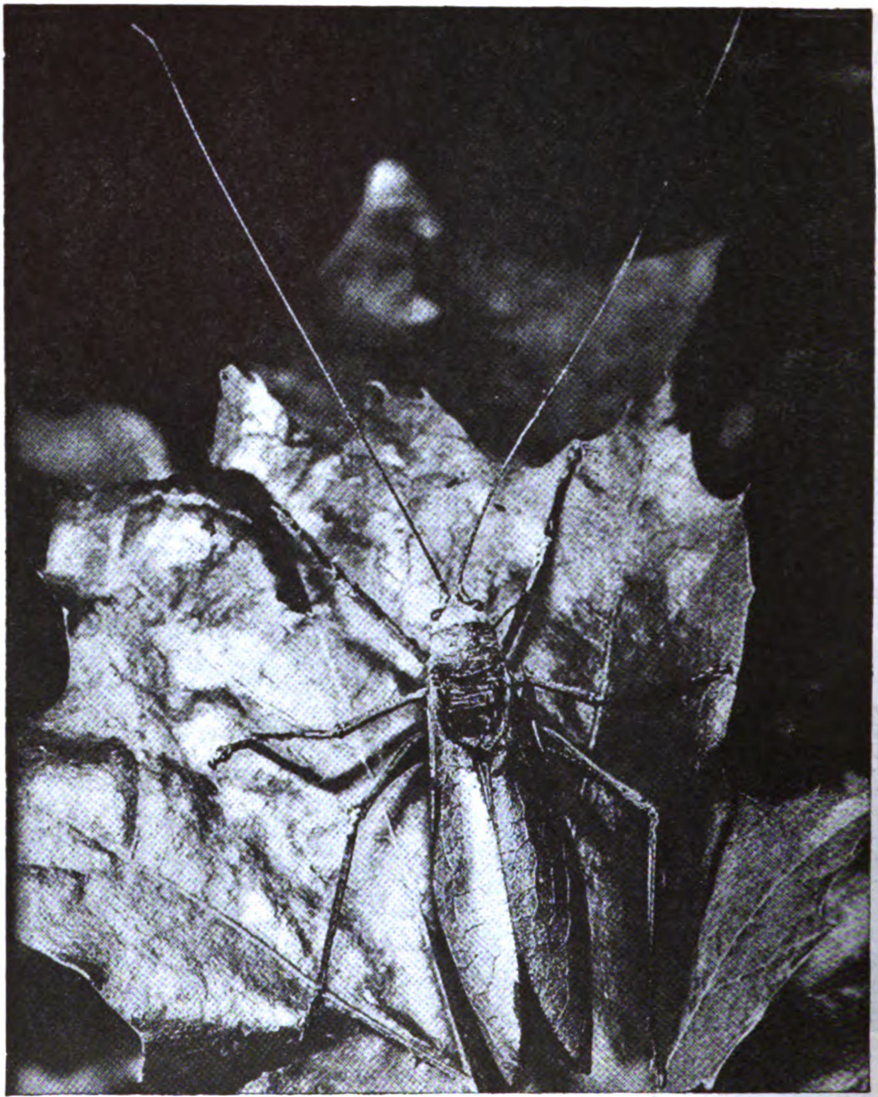
WILL WE RECEIVE RADIO MESSAGES FROM DISTANT PLANETS?

Radio impulses travel at the same speed as light—186,000 miles a second. A signal sent to us from some planet on the frontiers of the Milky Way, to be recorded today, would have had to start on its journey twenty-three centuries before Christ!

are most convincing, *that gravitation is a push instead of a pull;* that the impingement of ether vibrations tends to push all masses of matter toward one another, because a body casts an ether shadow in proportion to its mass toward another body to which it is apparently attracted. He has also further determined that there is a difference between weight and mass of certain bodies, for the reason that all bodies do not resist the ether exactly according to their mass, with resultant proportionate gravitative force.

If gravitation is a push instead of a pull, then, when on the side of the earth away from the sun, we are under an ether pressure of forty tons to the square inch and do not know it.

The intense agitations of the ether do not interfere in the least with the transmission of our radio messages, for there is room down in the regions of the ultimate for many different agitations to



Brown Bros.

ONE SMALL KATYDID CAN MOVE 6,000,000 TONS OF AIR

When this insect creates sound-waves that are audible half a mile away, he is setting in vibration a cubic mile of air. And air has weight that can be measured by means of the instruments of science.

abide together without interference. There are spaces which are relatively as enormous between things infinitely little as there are between the starry magnitudes of the heavens.

All of the suns in the universe have for all time been pouring their light and heat into space, which have been absorbed by the ether in the shape of vibrations which move onward and outward in all directions forever. Consequently, with time enough—and there has been time enough—the suns must of necessity have created an intensity of vibrations in the ether equal to that which exists on the face of a blazing sun. But all those vibrations do not exist as visual light and heat that can be sensed.

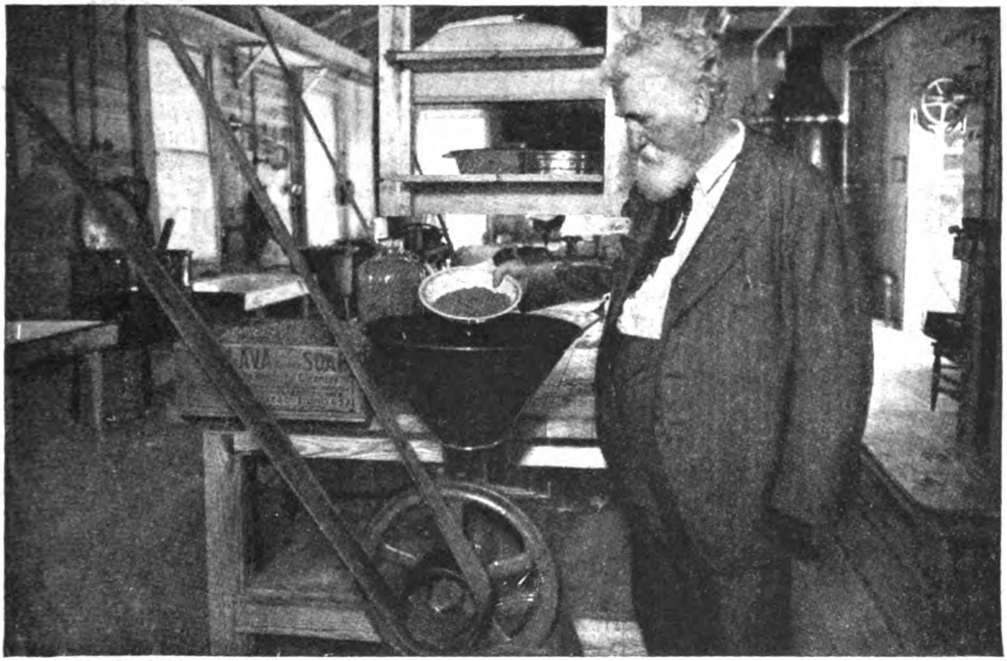
As a matter of fact, the latest discoveries in science indicate that not only do the suns pour their light and heat into the ether, but also that the ether reciprocates by restoring to the suns their lost light and heat, through the intense bombardment or hammering of their masses by etheric vibrations. Professor Jeffries, of Cleveland, Ohio, a noted scientist, has reached the brilliant conclusion that it is the ether that keeps the suns hot.

Let us take one more look at the ether:

Every particle of matter on the earth is in a state of intense vibration. All living things on the earth are, by reflected light, sending their images out into the ether, where they will go on for ever. Even every thought we think shakes the ether. We may die, but the impressions which we make on the ether are immortal.

If we could fly out from the earth with a speed sufficiently great, we would overtake the rays of reflected light which left the earth thousands and millions of years ago. If we were possessed of infinite vision, we could, as we went, look back and see the history of the earth unravel. We could see all of our cities fade away into the primal forest. We could see man return to the hill-cavern, and then back to the ape-like animal, swinging on the trees of a tropical jungle. Farther back still to the lemur, and back —away back—to a little agile lizard in the reptilian age, flitting about and living by its wits among the giant saurians, which we should see wallowing in the ancient ooze.

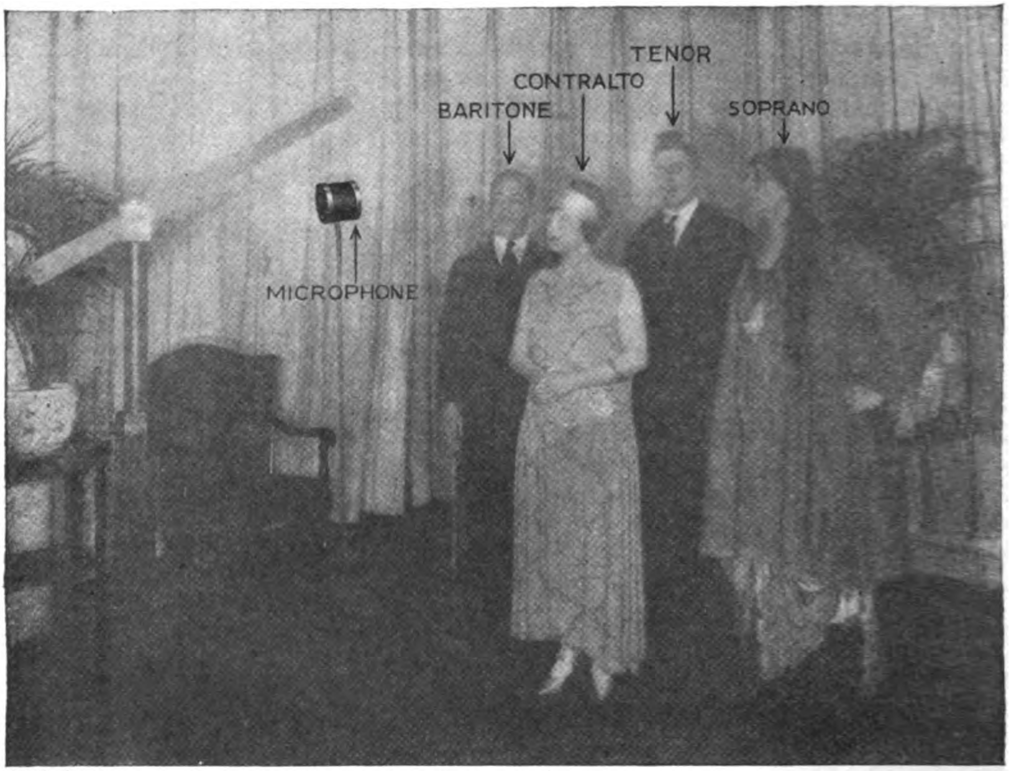
We should see our ancestry unwind back to the fish, from whose fins the mind has forged the human hands. And from the fish we should finally see evolution devolve back to the moneron, a little speck of protoplasm, the parent of all life, plunged in the azoic sea.



Press Illustrating Service

"WE MAY DIE, BUT THE IMPRESSIONS THAT WE MAKE ON THE ETHER ARE IMMORTAL"

So Hudson Maxim expresses in a phrase the scientific hypothesis that the impulses that our bodies originate never come to a final (mathematically speaking) rest. This picture of the distinguished inventor of Maximite shows him at work in his experimental laboratory at Landing, New Jersey.



Westinghouse

HIGH VOICES HAVE MORE INTENSITY

Consequently the sopranos and tenors are placed farther from the microphone than the contraltos, baritones and basses, in order to give proper values to the transmsision.

Mixing Music in the Microphone

How the modern radio impresario is overcoming the mechanical difficulties that arise in the broadcasting of *ensemble* music in which each voice and each instrument must be blended into an harmonious whole

By C. L. LE MASSENA AND WILLIAM H. EASTON, Ph.D.

ANY new invention that becomes popular too suddenly, before its details have been thoroughly worked out, is apt to run foul of unexpected difficulties. Such was the case with the automobile, the submarine and the airplane. And such likewise has been the case with radio.

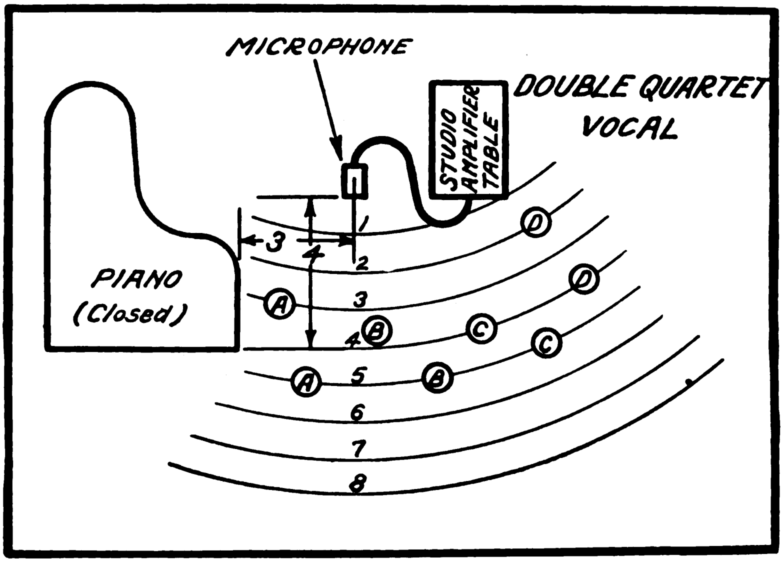
Urged onward by a too eager public, hundreds of broadcasting stations started operations with little knowledge of either the scientific or the artistic principles involved; in consequence, the noble art of music was in danger of being dragged into disrepute.

Music by radio presents many different and intricate scientific problems, such as the proper selecting, arranging and handling of the various elements that go to make up a musical production.

Radio broadcasting began with the phonograph, the player-piano and vocal solos. Then came a rush of vocal and instrumental duets, trios, quartets, bands, orchestras and choruses. Now, groups of vocalists and instrumentalists, large and small, cannot be handled at random. In the concert hall the several divisions are carefully placed in accordance with the experience of many years, and because the sound waves have ample room to expand and travel to the ears of the audience, excellent results are obtained.

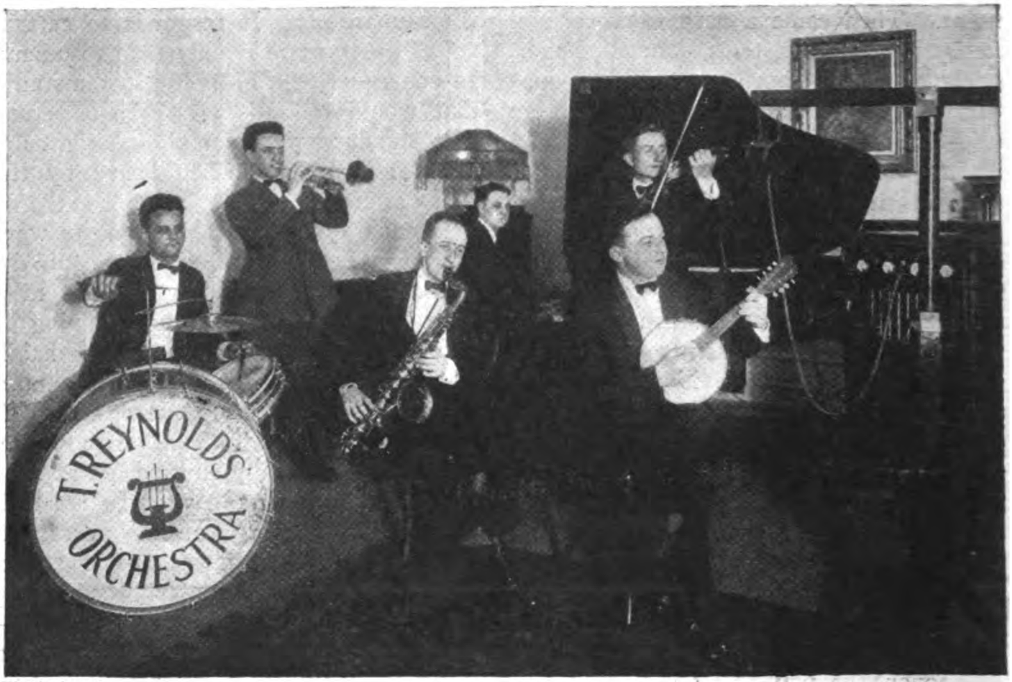
But in the broadcasting studio the space is small. There is no audience, only the microphone, and all tones have to reach this single point with exactly the right intensity. Nor are the instruments played in the same plane. Double-bass players stand, all others sit. The violin and viola are held under the chin, the cello between the knees. Flutes, fifes, trumpets and bugles are held high. Other wind instruments are kept low. Moreover, the players sit behind music-stands, so that the sounds are deflected upward from the music sheets. Finally, the characteristics of the average microphone are quite different from those of the human ear. It responds to certain voices much more readily than to others. In consequence, a grouping in the studio that would be satisfactory to a person who stands at the microphone might not be at all pleasing when heard by the radio audience.

Phonograph recording difficulties were overcome because the records could be studied before marketing them. Mistakes by singers or a wrong grouping of an orchestra were mere matters of detail. Poor molds were destroyed and new ones made until a satisfactory one was secured. But this is not the case with radio. Sounds, as originally emitted, go at once to the public. They cannot be recalled. Radio music must attain perfection through open experiment. The studio managers of all the better broadcasting stations listen in on radio receivers constantly, in order to check the character of the performances, and many stations have official outside critics who phone in comments and suggestions. Such arrangements are valuable at all times, but to put entire dependence upon them



THE CORRECT POSITION FOR A DOUBLE QUARTET

The basses and baritones (indicated by A) should be placed nearest to the microphone. The contraltos (B) come next; then the sopranos (C), and then the tenors (D). The arrangement takes into consideration the importance of the parts sung as well as the tone values of the voices.



Westinghouse

A Correct Grouping

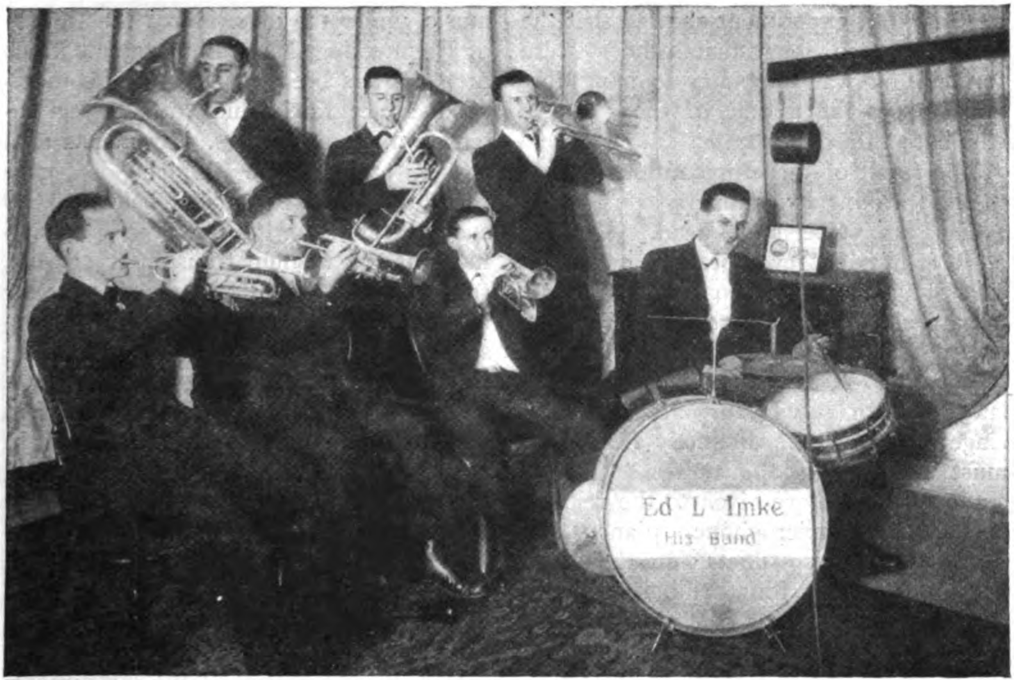
Here the violin, saxophone and banjo—the more quiet instruments that carry the melody—are placed in the foreground, while the penetrating brasses and the loud percussion instruments, such as the piano and drums, are placed in the rear.

means too much public experimentation. Hence, accurate standards, that can be applied in advance, have been sorely needed.

In order to develop such standards in transmission of music, the Westinghouse Company assigned the task to A. G. Popcke, one of its engineers, who is also a musician. He spent months at the work, studying the radio qualities of every kind of sound and every possible combination of sounds. In this task he was assisted by the "modulation meter," an instrument specially developed by the Westinghouse Company for the purpose. This instrument, which resembles an ordinary ammeter, is connected in the microphone circuit and indicates the strength of the currents controlled by the sounds that reach the microphone. It has a scale from 1 to 100. Sounds producing currents below 10 on this scale are too weak to hear, while those producing currents above 90 are so strong as to cause blasting. Consequently, by watching this instrument, the modern operator obtains exact information as to the values of the sounds that are actually being broadcast.

If the modulation meter registers too high during a selection, the amplification of the microphone current is reduced, or the microphone is moved away from the musicians, until the sounds are softened sufficiently to be properly transmitted. If the meter registers too low, the amplification is increased or the microphone is brought nearer. In a similar manner, the radio intensity of each particular voice and instrument can be determined, thus giving exact data for groupings.

Some of Mr. Popcke's conclusions are at variance with what might be expected. Thus, for solo work, a bass singer must stand nearer the microphone than a tenor or a contralto, while a soprano must



Westinghouse

—and a Wrong Grouping

Loud instruments placed near the microphone tend to "blast" the transmission and to drown out the weaker-voiced instruments in the background. The drums are special offenders, and often ruin the broadcasting of orchestral ensembles.

stand farther away than any other singer. In a well-balanced mixed quartet, the contralto and bass are nearest, the soprano and tenor at greater distances. With an orchestra, the cello and double-bass are nearest, and the violins and violas are ranged in a semicircle behind the cello. The flute and clarinet occupy the next rank, the brass instruments next, and the drums are placed in a far corner. Singers of comic songs must stand closer to the microphone than singers of classical music, because the words of comic songs are the most important part and must be heard distinctly, whereas in classical songs, words and music are equally important. Where instruments and parts are duplicated (as with two violins, mandolins or saxophones) the players must play in exact synchronism or the sounds will become blurred.

The studio must be so constructed and draped that all echoes and reverberations are eliminated. There are different ways of doing this. In the WGI studio at Medford Hillside, Mass., the walls and ceiling are treated with a special acoustic felt, after the method that is employed in record-reproducing studios. The floor is covered with a heavy carpet. The WGY studio at Schenectady has a large rug on the floor and the windows are draped with loose, light curtains. In the Navy Department studio, NOF, at Anacostia, special sound-damping devices and paraphernalia are rigged up on the walls, ceiling and floor so as to prevent reverberation of sound waves and to insure good reproduction. In the Westinghouse studios the practice varies. At KDKA, Pittsburgh, and WBZ, Springfield, shirred burlap covers the walls and ceilings and heavy carpets cover the floor. The Newark studio, WJZ, is specially constructed of sound deadening material, but experiment showed that the room was so long that echoes were formed. It was necessary to hang curtains across the middle of the room to eliminate this difficulty.

The result of these precautions is that to one speaking in a properly constructed studio his voice feels dead. We are used to hearing reverberations when we speak and the suppression of them seems unnatural. The absence of all outside noises helps to emphasize this effect.

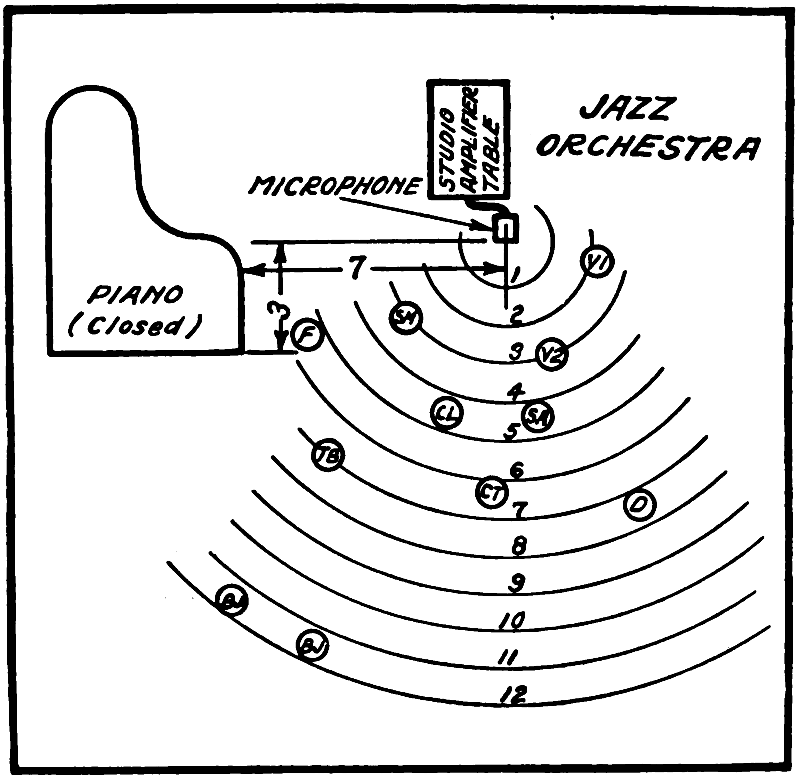
The piano is, as always, a special problem. When used for accompanying singers, it must be distinctly heard but must not drown the noises. Careful study was therefore given to the relative positions of microphone, piano, and soloists, and also duets, quartets and choruses. It was found that the greater the number of voices, the greater must be the intensity of the piano music at the microphone. Groupings were therefore worked out for each combination of singers. Mr. Popcke has reduced his findings to a series of charts, two of which are reproduced. These charts are used by the studio managers of the four Westinghouse stations—KDKA, Pittsburgh, WJZ, Newark, N. J., KYW, Chicago, Ill., and WBZ Springfield, Mass. Thus, all stations operate according to the same standards. Other stations are likewise experimenting along these lines. For example, at the General Electric station, WGY, at Schenectady, more than one transmitter is used for the broadcasting of a church service where the choir, the minister and the organ are in three different places, not in close proximity. In this instance, three microphones are used in parallel. Three microphones are used in broadcasting WGI programs from Medford Hillside; two are used exclusively for musical entertainments, orchestral concerts, choruses and solos and one is used for speaking.

The NOF station at Anacostia, D. C., is engaged in experimental work along lines of reproduction of speech and music, under the direction of the Bureau of Engineering, Navy Department. Much progress has been made in efforts to reproduce accurately and with correct intensity all sound waves. By means of a special microphone which is non-resonant to frequencies below 3,000 cycles, together with the proper adjustment of the vacuum transmitter circuits, sound waves of all frequencies below 3,000 cycles are reproduced well with respect to intensity and frequency. While this station has no fixed activities, it broadcasts band concerts twice weekly as part of the effort to solve one of the major problems under consideration, *viz.*, the quality of tone modulation. When one to three artists are singing or playing only one microphone is used, while in the case of an orchestra two are used. The instruments are placed at various distances from the singers or players according to the nature of the instruments and the classes of singers who are performing.

The acoustics of a studio represent a problem in three dimensions.

Suppose, for example, high C is struck on the piano. On exploring every cubic foot of the studio's interior, a point will be found where, due to the various echoes and reflected sound waves in the room, that note will be received at its best value. Now strike a deep bass note, and the chances are that that particular note will be best received at some other point because its waves will be echoed and reflected in a different manner. Obviously, therefore, the location at which a piano selection as a whole is best received will be a compromise; that is to say, will be the point where only the majority of the notes will best be received. Conditions are, of course, still worse when an orchestra is playing.

The consequence of this situation is that before using the charts the acoustic properties of the particular studio must be thoroughly known. The microphone must be placed in the best spot for the particular music to be broadcast and the



HOW AN ORCHESTRA SHOULD BE ARRANGED

The first and second violins (V1, V2) and the melody saxophone (SM) are placed close to the microphone; farther away are placed the saxophone that plays the accompaniments (SA), the flute (F), and the clarinet (CL). In the background are the cornet (CT), the trombone (TB), the drums (D), and the banjos (BJ).

musicians then arranged in accordance with the chart. However, if the studio is perfectly echoless and reflects no sound waves whatever, then all points within it will be equally good for reception. This degree of perfection is probably impossible to secure, but evidently the better the sound-proofing the less the distortion and the better the artistic results. KDKA's new studio, for example, has sound-proof walls; the walls, ceiling, and floor are covered with a heavy layer of felt and the walls and ceilings are draped and the floor has a thick carpet. The result is that the room is practically echoless, and the music broadcast is notably excellent.

During the pioneer days of radio there was no precedent to follow and little experimental knowledge to guide; therefore guesswork was inevitable. In broadcasting the Mozart opera, *The Impresario,* from WJZ last winter, the five singers were rehearsed before a dummy microphone, and were shifted so as to bring each singer before the recording instrument in turn. When several sang together, their heads came in close proximity. Today this arrangement would not be employed. The groupings would follow the new scientific method as described, unless one of the artists possessed an unusually powerful voice, in which case proper adjustment would have to be made.

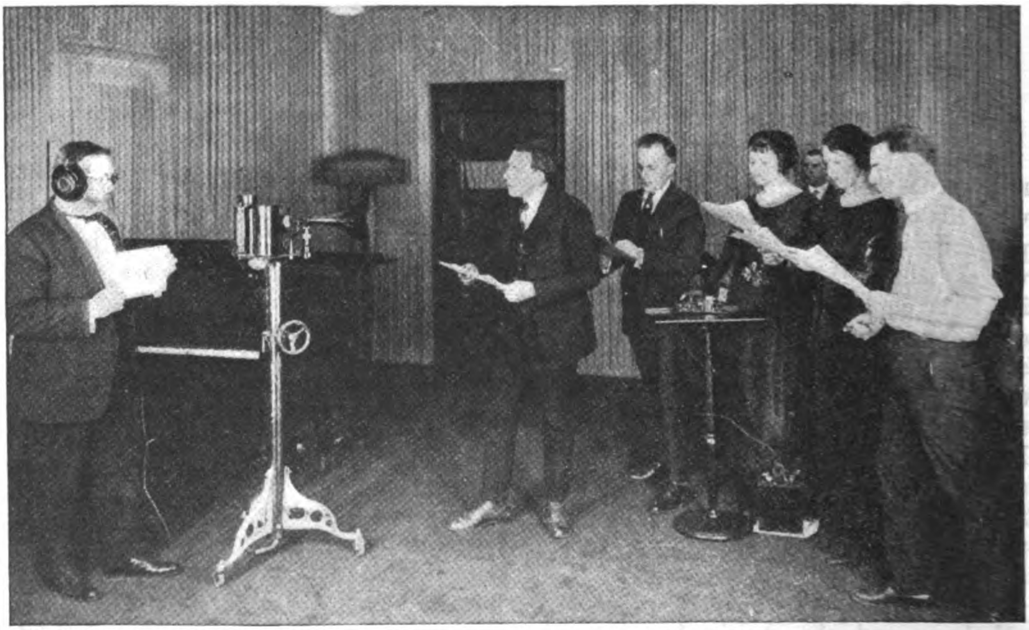
Much more difficult than broadcasting music from the studio is the broadcasting of grand opera from the opera house. The pioneer work of this kind was done by the Chicago Westinghouse station

KYW which transmitted practically every performance of the Chicago Opera Company during the 1921-22 season. For reasons that are obvious, no single microphone could handle soloists, chorus and orchestra. Several microphones were therefore installed in various parts of the stage and house. These were connected to a little switchboard in the wings, and an operator connected in first one and then another in accordance with the character, volume and location of the music and singers. The results, while interesting from an experimental standpoint, were not all that could be desired artistically.

The same may be said of attempts to broadcast symphony concerts where a large number of musicians are employed with but a single microphone and no scientific grouping of the instrumental bodies.

To get the best results, operas should be performed in specially designed studios and with specially selected forces. Not every opera is suitable for this purpose. William Wade Hinshaw, producer of Mozart's *The Impresario,* claims that only the lighter forms, where solo singers do most of the work, can be broadcast.

Many new problems have to be solved in order to obtain an operatic performance by radio of the highest artistic character. Large orchestras or choral groups are just as much out of place in a broadcasting studio as they are in a phonograph recording laboratory, because the fewer the combinations employed, the better is the effect. Scientific grouping and selection is therefore imperative. Soloists, chorus and orchestra must be arranged so that each group can function independently or conjointly as occasion demands. All of these things require further artistic and scientific investigation and experiment until a *modus operandi* is devised that can cope with grand opera requirements. Then radio music will have fulfilled its possibilities.



International

AN "UNDRESS PERFORMANCE" OF A PLAY

The broadcasting of a theatrical production from a studio (in this case from WGY) not only permits the actors to appear without costume and make-up, but enables each performer to advance and talk directly into the microphone. The director listens in with padded earphones and coaches his cast by means of instructions written on cards.

FOUR WAYS TO GET GOOD

MODULATION

PART I

The four standard methods may be listed as (1), the use of the microphone in the antenna circuit for low-power transmission; (2), the use of a magnetic transformer; (3), grid modulation and (4), Heising modulation. The first two of these methods are here described by one of the foremost authorities in this field—

PROF. J. H. MORECROFT

IF we breathe quietly the lung pressure forces air in and out through the throat in a fairly uniform stream, but if we talk or sing the air emerges through the throat chambers in a series of puffs. A delicate mechanism for indicating air pressure placed near the mouth would show that the air pressure varied periodically above and below its normal value. The frequency of this pressure variation is determined by the pitch of the voice and the intensity or strength of the voice determines the amount by which the pressure of the air varies from its normal value. If the pressure-indicating device were so arranged, we might connect to it a light-weight pencil, and this, through a suitable system of motion-magnifying levers, would enable us actually to draw the form of the air-pressure waves.

Typical curves which might be thus obtained are shown in Figure 1; curve *a* is for a comparatively weak violin note about one octave above middle C of the piano, while curve *b* is for a more intense note, of more complex quality, with a pitch of about fifty a second.

The problem in radio telephony is to let these pressure waves of the voice act on the apparatus at the broadcasting station in such a way that a simple receiving circuit will send off pressure waves from the diaphragm of the head phones which are sufficiently like those actuating the transmitter for the voice to be clear and recognizable. If the pressure waves at the transmitting and receiving stations were actually drawn by an instrument of the kind I have suggested, the eye would probably not recognize them as the same, yet so wonderful an instrument is the human ear that it, in combination with the brain processes by which we are made conscientious of sound, would interpret them as the same.

The waves shown in Figures 1A and 1B are periodic waves; that is, the wave forms are repeated many times with approximately the same shape. This is the kind of wave given off when a vowel sound is sung, or a violin string bowed or a simple note on a wind instrument is sounded.

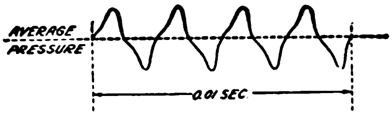


FIGURE 1A

A graphic record of a high musical note of a violin, one octave above middle C. Compare this record with that on the facing page.

The voice contains many sounds, however, which are not periodic; sounds in which the wave forms do not repeat themselves. In this class fall all the consonants—the explosive sounds of the voice, such as p, k, t and s. The periodic or vowel sounds of the voice are much easier to reproduce by radio than are these consonants, in fact, practically all the improvement which will be made in the quality of radiophone transmission will come about by changes in the apparatus, at transmitter and receiver, to "get through" more of these consonant sounds. The next time you listen in with a loud speaker, try to analyze the sounds you hear and estimate how many of the consonants are coming through with their proper relation to the vowel sounds; you will be surprised to find how few of the consonants you actually hear. What you really hear is a series of vowel sounds; the brain generally "injects" the consonants to a sufficient extent to make the speech intelligible; when it doesn't do so you do not understand the speech. There may be plenty of noise there but when you listen to it carefully you will find that it is actually made of sounds that are practically nothing but vowels.

At the broadcasting stations it is necessary to generate and radiate high-frequency, electromagnetic waves from the antenna, the frequency of which shall be essentially constant but the amplitude or intensity of which shall vary in a manner corresponding to the form of the pressure waves of the voice. The frequency of the waves sent off from the antenna must be very high (say of the

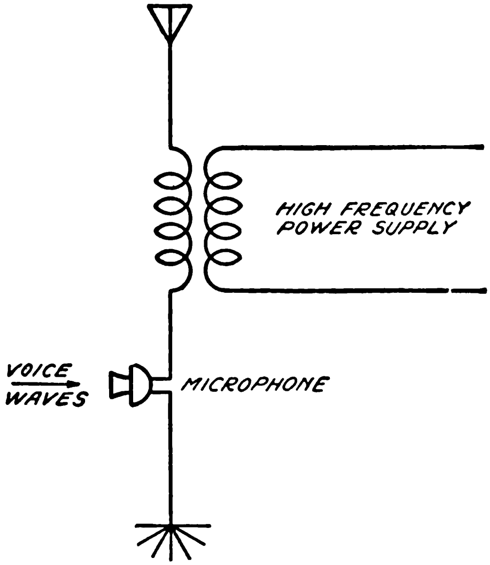


FIGURE 2

The most simple scheme for modulation. The microphone is connected in the ground lead.

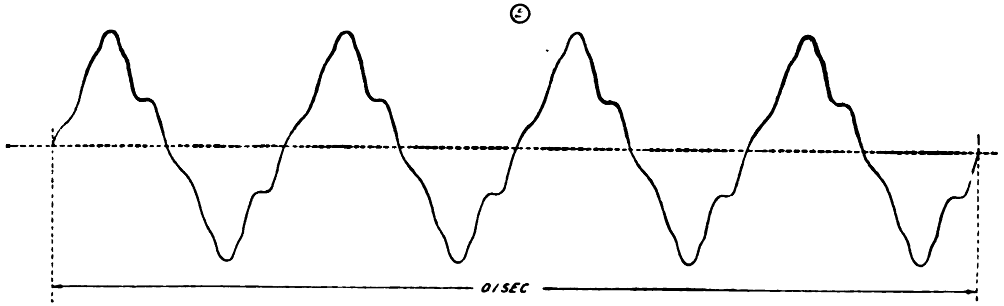


FIGURE 1B

A graphic record of a low note of a violin, of less than 50 vibrations a second.

order of one million a second), or else not much power will be radiated and the resulting signal at the receiving station will be correspondingly weak. The task of the radio engineer is, therefore, to generate at the station plenty of high-frequency power and arrange the generating apparatus in such a way that the minute power of the voice, measured possibly in the thousandths of a watt, can accurately control its activity. This minute power of the voice must be able to control perhaps a horsepower of electrical oscillations and control this power so decisively that it changes from practically nothing to a horsepower or more hundreds and thousands of times a second.

In some of the experiments in trans-oceanic telephony this extremely small power of the voice controlled the flow of energy from a two hundred kilowatt generator—not only made this tremendous amount of energy to flow and cease flowing into the antenna hundreds of times a second but made the form of this periodic fluctuation in energy flow conform closely to the pressure wave of the voice.

We shall consider some of the schemes by which this voice control of the antenna power is brought about.

The most obvious scheme and that first tried, is to put the microphone directly in the antenna as indicated in Figure 2. The high-frequency power for radiation from the antenna is supplied from some kind of a machine to the antenna through the coupling transformer shown.

The microphone consists essentially of a mass of closely packed carbon granules through which the current flows. Practically all of the resistance of such a mass of granules is at the points of contact of the various particles and this contact resistance varies greatly with the amount of pressure exerted on the granules. The metal diaphragm of the microphone, against which we talk, presses lightly against the mass of granules; hence it follows that by varying the pressure on the diaphragm the resistance of the granule contacts may be greatly changed.

When the voice waves impinge on the diaphragm it alternately presses and releases the carbon granules and so varies the resistance of the microphone as a whole.

With an arrangement like that given in Figure 2 the amount of high-frequency current that flows in the antenna depends directly upon the antenna circuit resistance and this is affected by the resistance of the microphone, because whatever current flows in the antenna must evidently flow also through the microphone. Hence the amount of antenna current, which determines the signal strength at the distant receiving station, fluctuates according to the voice waves that impinge upon the microphone diaphragm.

This arrangement has the advantage of simplicity and it was used in practically all of the early attempts at radio telephony; it has many undesirable characteristics, however, and is seldom used today. Comparatively small amounts of power can be controlled in this fashion, as the microphone can carry only small currents without overheating. The scheme is very inefficient; 50 per cent or more of the high-frequency power supplied to the antenna is used up as heat in the microphone itself, and the amplitude of the antenna current does not directly follow the voice-wave pressure on the diaphragm of the microphone so that the variation of antenna current does ***not*** truthfully represent the voice wave; the ***modulation*** is imperfect.

Another scheme which has been used to some extent at both small and large radio transmitting stations is that indicated in Figure 3.

The high-frequency power is supplied as before from a machine or tube through the magnetic coupling as shown, but instead of placing the microphone in the antenna circuit, an iron-core coil is so placed. This iron-core coil is fitted with two windings, one connected in the antenna circuit and the other carrying a continuous current; the fluctuation of this continuous current follows the voice waves because the microphone is placed in series with this winding, as shown on the diagram.

The modulation in this scheme is accomplished by detuning the antenna. To absorb considerable amounts of power from the power supply the antenna must be accurately tuned to the frequency furnished by the power supply; any departure from this tuning will at once cut down the amount of power supplied to the antenna. Due to the magnetic properties of the iron core the amount of inductance of the coil depends upon the amount of current flowing in winding B so that the tuning and detuning of the antenna follow the fluctuations of the continuous current in winding B and this in turn, depending upon the resistance of the microphone, fol-

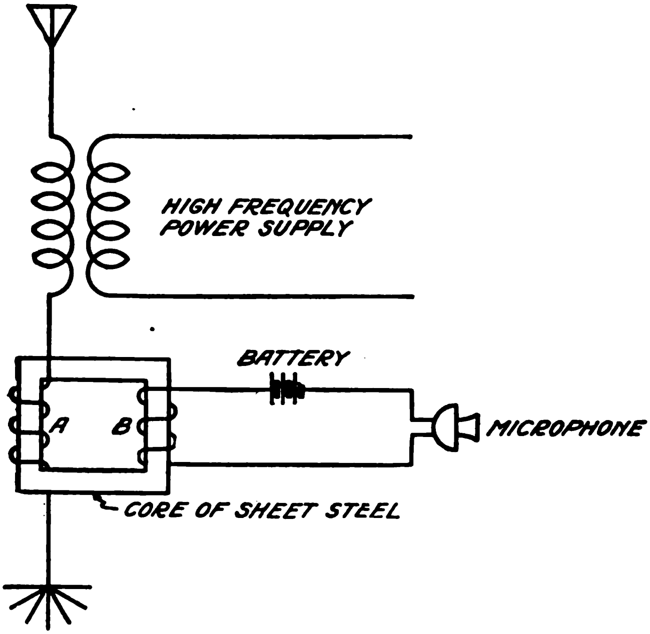


FIGURE 3

Another system for modulating in the antenna; it is called "magnetic modulation." This is accomplished by a special type of transformer which varies the tuning of the antenna circuit in accordance with the voice waves that are impressed upon the microphone.

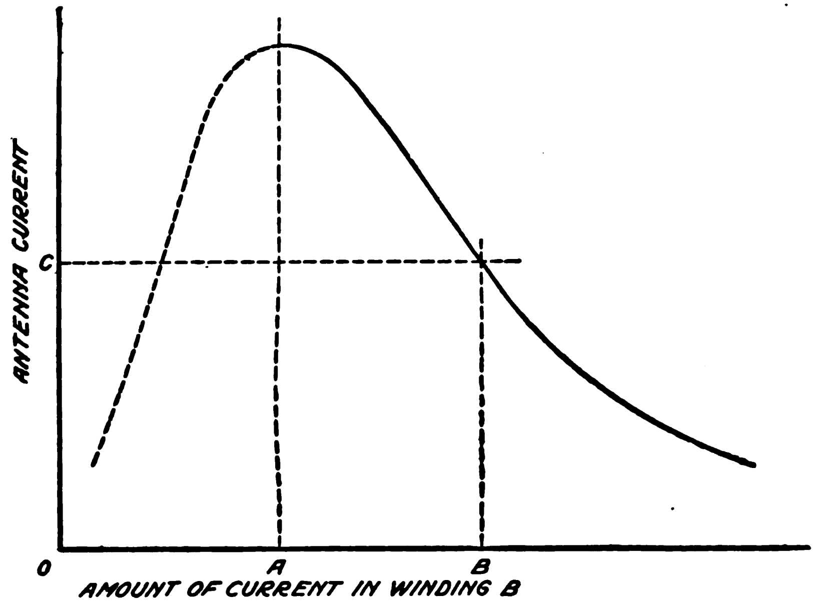


FIGURE 4

This curve shows the variation of the antenna current plotted against the variation of the microphone current. A change in the microphone current causes a change in the antenna current; in this way the radio waves are shaped into the form of voice waves.

lows the pressure of the voice-wave.

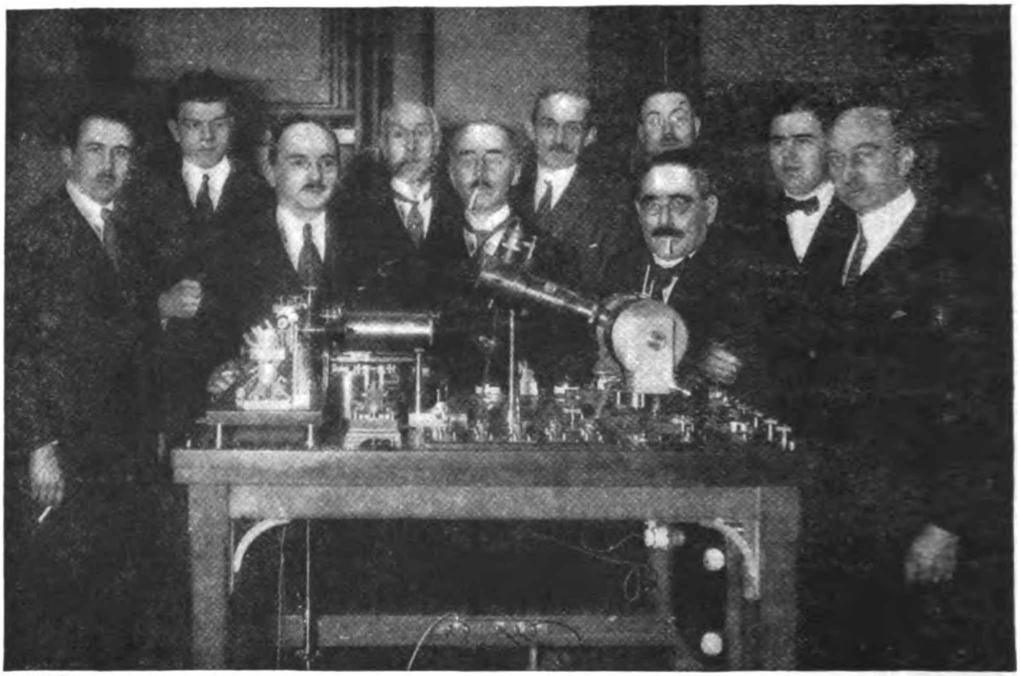
The variation of antenna current with the amount of continuous current in winding B is about as shown in Figure 4; the workable part of the curve is that shown in the full line. With an amount of continuous current equal to A the antenna is tuned to the power supply; so the antenna receives a maximum of power; for currents greater than A the antenna current proportionately decreases. Normally the antenna current is equal to OC and the amount of current in the winding B of the coil is OB. As the pressure on the microphone increases the current through B increases, thus decreasing the antenna current and if the pressure on the microphone decreases, thus increasing the resistance of the microphone the continuous current through B decreases and the antenna current as a result of this increases proportionately.

When this scheme was actually used for controlling the large Alexanderson alternator at New Brunswick it was found necessary to use several condensers suitably connected and the continuous current through coil B was not controlled directly by the microphone but was controlled by some large vacuum tubes, the grids of which were actuated by the microphone.

As the iron core is subjected to high-frequency magnetic reversals, because of the antenna current through coil A, it is necessary to build the core of thin sheet steel plates and these plates must be carefully insulated from each other. The plates used are generally not more than two or three thousandths of an inch in thickness.

"What Is the Best Kind of Modulation for My Set?"

In the next article of this series Prof. Morecroft will point out the way to answer this question. Specifically, he will describe the grid modulation (adapted for single-tube receiving sets) and the famous Heising modulation —the most efficient of all, and adapted to all amateur transmitting stations.



Brown Bros.

THE INVENTOR GIVES A DEMONSTRATION

When M. Edouard Belin of Paris recently arrived in New York, he exhibited his latest device before a group of scientists. In the above picture the inventor is the fifth man from the left.

Secret Signals by Radio

Up to the present time all signals transmitted by radio have been regarded as "broadcast," to be picked up by any receiving station within the transmitting station's range. The ingenious apparatus described in this article shows how the transmitted signals can be recorded intelligibly only by special receiving sets—thus opening up the possibilities of restricting the messages or pictures within any desired limits

By PAUL McGINNIS

THE chances of intercepting radio messages sent by the "crypto" are so small that Edouard Belin, its inventor, knows no French shrug of the shoulders which will describe them. It is impossible to eavesdrop on its messages—if anything is impossible in radio.

The new device with which the noted French inventor has surprised American scientists in his visit to New York is used with his invention for transmitting photographs and written messages both by land wires and by radio which he is introducing in this country.

Six adjustable disks control transmission, and their combination is as difficult to guess as the combination of a lock on a bank safe. They split seconds for the transmitter. The transmission itself is an invention of world fame. It is able to transmit signatures accurately enough to be acceptable to banks. By it photographs and messages have been sent successfully from Paris to Bar Harbor, Me., and also from Beirut, Syria, to Paris.

The picture or photographed message to be sent is transferred to a brass cylinder and treated with chemicals so that it dissolves and leaves only the emulsion. As the cylinder turns it makes electrical contact with a small point of metal resting upon the emulsion. The current that flows through the cylinder and the point of metal is varied according to the resistance of the light and dark parts of the emulsion.

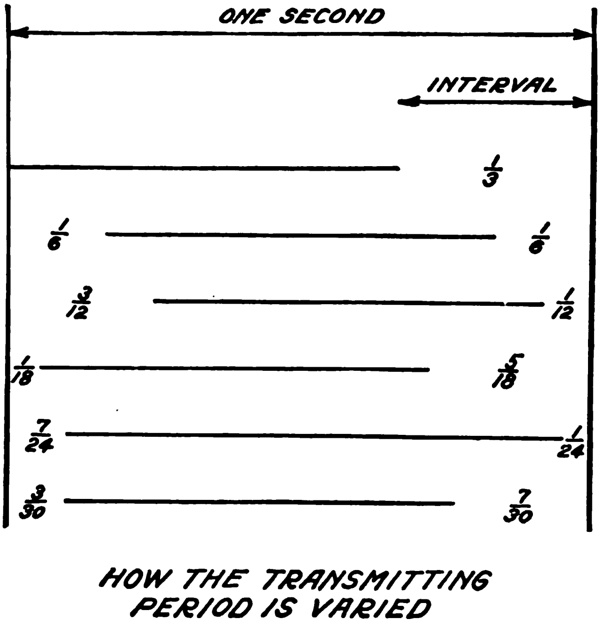
The current, with its variations caused by the light and shade of the photograph, is then superimposed upon a carrier wave and sent out in the usual manner employed to broadcast speech and music. The common modulation transformer is employed for this purpose.

The photographic message is received upon a sensitized cylinder similar to that used in transmitting. The two cylinders are timed to synchronism by a transmitted sound much like that of the metronome used for teaching rhythm in piano playing.

When the broadcast photograph is caught by the ordinary antenna and vacuum tube receiver, its pulsating current is led to an oscillograph where a loop of fine wire suspended in a strong magnetic field bears a mirror about the size of a pin-head. This small loop of wire moves back and forth as the current becomes stronger or weaker and changes the direction of an intense beam of light reflected by the mirror.

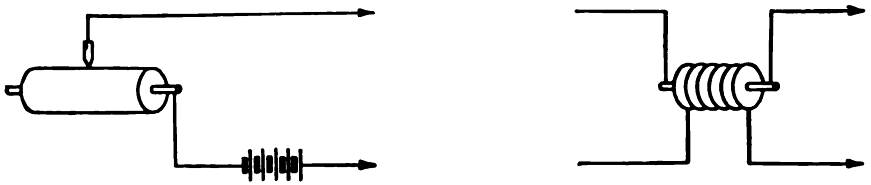
The beam of light moves over a glass slide which varies from opaqueness at one end to transparency at the other. After the light has passed through the slide, a lens concentrates it upon the sensitized revolving cylinder and reproduces there a small strip of the picture at each revolution.

With these comparatively simple instruments, the picture can be intercepted and taken from the air by anyone, but with the addition of the crypto the task of listening-in becomes hopeless. One small strip of the picture or message sent out by one revolution of the transmitting cylinder might be received perfectly, but as the interval between revolutions is constantly changed the strips would not coincide.



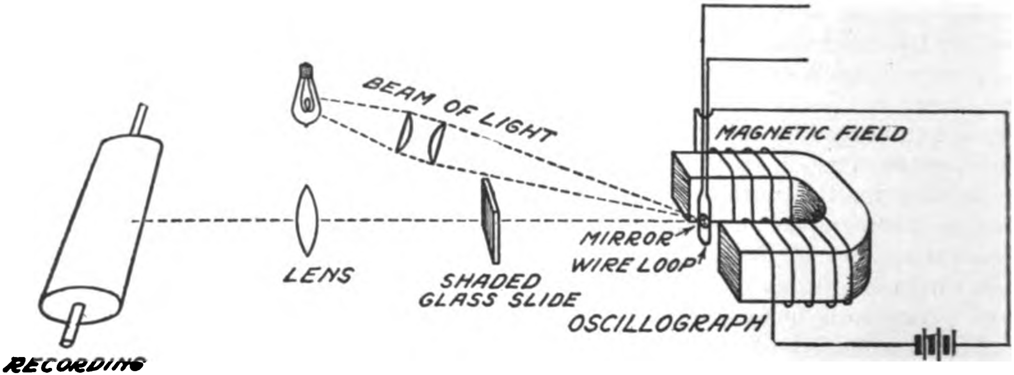
HOW THE RADIO SIGNALS ARE "SCRAMBLED"

FIGURE 1: *This chart shows how the "crypto" scrambles a picture or message transmitted by radio and makes it practically impossible for another receiver that is not equipped with it to solve or unravel the otherwise meaningless jumble of signals.*



CYLINDER AND TRANSMITTING CIRCUIT

THE CRYPTO



RECEIVING CIRCUIT

HOW THE DEVICE WORKS

FIGURE 2: *The transmitting cylinder upon which the picture is made in bas relief varies an electrical current which is transmitted to the crypto and sent out over a telephone wire or by radio. At the receiving end the current is led into the reconverting apparatus (as shown above) and is changed into a light wave, of varying intensity, which is traced upon another cylinder, thus reproducing the picture. A crypto is used at both ends to scramble and unscramble the transmitted impulses and the two devices are run synchronously.*

If each revolution of the cylinder requires 2/3 of a second, there will be an interval of 1/3 of a second during which time the cylinder does not revolve or transmit. It is this inactive interval which is made use of to insure secrecy. This is done by distributing it in various combinations, part before and part after the given revolution.

As shown in Figure 1, the first revolution occupies 2/3 of the first second, after which there is an interval of 1/3 of a second. Since a different combination is used in the second revolution, the 1/3 of the first revolution is added to the 1/6 which precedes the second revolution, making a total of 1/2 second between the transmission of the first and second strips of the messages. The combined interval between the second and third strips is 5/12 of a second; between the third and fourth it is 13/36.

Unless the receiving apparatus responds exactly to these delicately timed intervals, the received message will be nothing but meaningless lines of light and shade.

The crypto controls the intervals by means of its six adjustable disks which move in synchronism with the revolving cylinder. Each disk bears the figures from 0 to 9, and can be adjusted to any figure in a moment. The six disks may be combined in 999,999 different ways. The chance to intercept the message, therefore, even with the aid of another crypto, is one in a million.

Ordinarily an inventor might be content to call such a machine a secret instrument and let it go at that, but Belin has gone one step farther. He has considered the possibility of an ear or an instrument sensitive enough to detect the intervals. To eliminate this he has disguised them. What are called "parasites" or unintelligible signals are automatically sent out during the intervals. When they are transcribed, they form a meaningless strip of light and shade, but they are so much like a part of the message that any listening in would be unable to tell where the message stopped and the "parasite" began.

The device has its shortcomings when used with radio, but it is a large step in the direction of secrecy and so far it is the only invention which completely foils the eavesdropper.

Both static and interference from other stations will alter the current received and consequently affect the picture or message photographed on the receiving cylinder. But with added equipment, the invention is considered to be practical. A loop antenna will reduce interference from transmitting stations and from static almost half, and the methods of Marconi and others in sending unidirectional waves will reduce other objectionable features by another large fraction.

Marconi's beam of waves, sent out by an antenna shaped like the reflector of an automobile headlight,* cannot be intercepted by any station not directly in their narrow path. They may easily be applied to the crypto.

Belin's apparatus is now being installed to transmit press photographs in the United States. This is only the beginning of its service.

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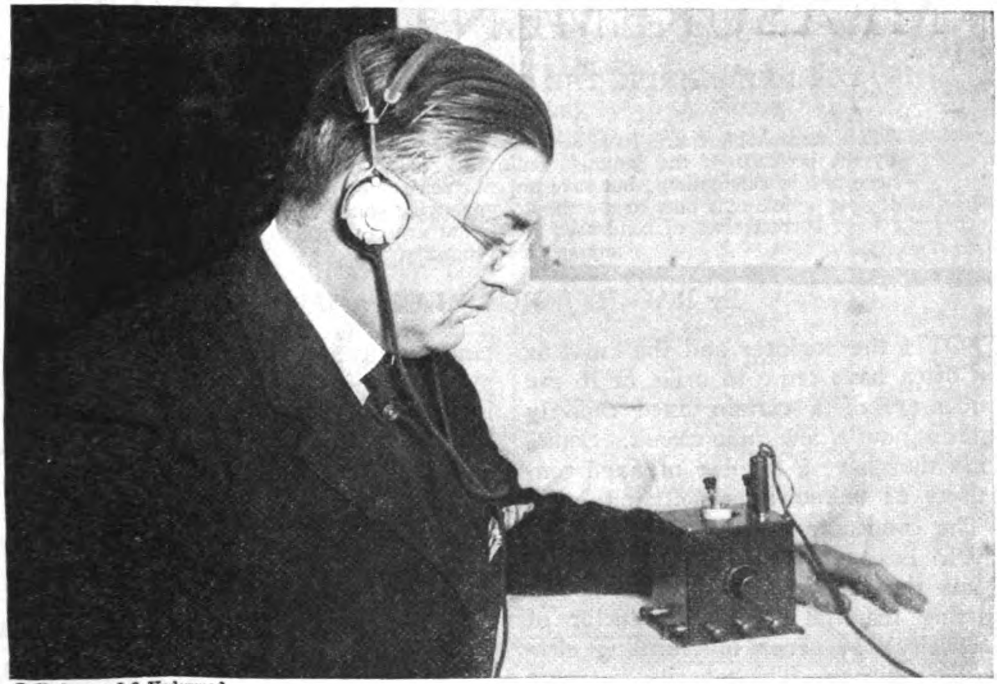
*See POPULAR RADIO *for March, 1923.*



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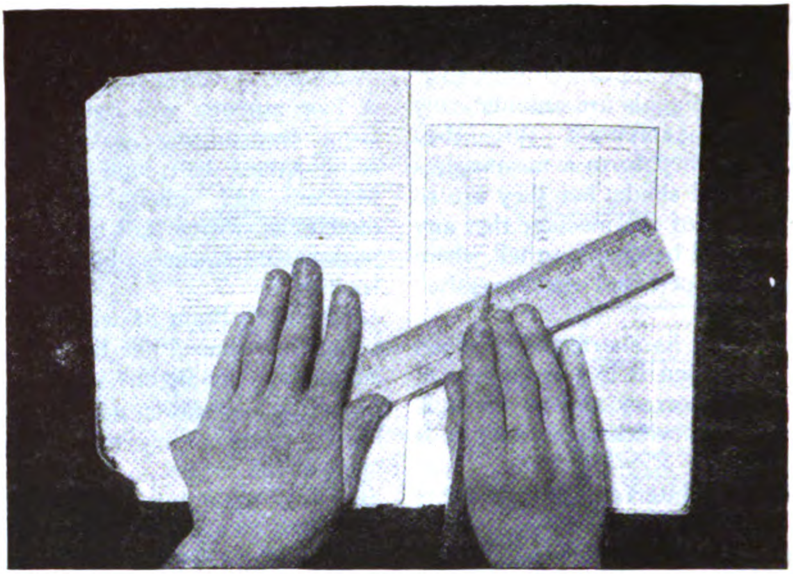
A UNIQUE RECEIVER IN A FOUR-INCH BOX

This midget set contains a dry-cell tube rheostat and a tuning transformer, and is capable of picking up signals from distant stations without the use of amplifiers. This receiver enables its designer, Dr. R. S. Piper, to hear broadcast programs from all over the United States from his home in Chicago. It is certainly one of the most powerful and effective receiving sets of so small a size and compact arrangement that has yet been constructed.



ALL YOU NEED IS A RULER, A PENCIL AND A PAIR OF HANDS

By means of the table on the opposite page the amateur who builds his own apparatus may calculate in an instant the design for a condenser that will have a pre-determined capacity, or find out the capacity of a condenser that is already built.

MEASUREMENT CHARTS

FOR DETERMINING THE CAPACITY OF A CONDENSER

ARTICLE No. 3

These remarkable charts have been developed especially for Popular Radio by the inventor of the famous "radio slide rule." They not only insure accuracy in calculations, but save an enormous amount of time. The following article tells how to use the accompanying chart for determining the correct sizes of condenser plates that are designed to obtain any specified capacity.

By RAOUL J. HOFFMAN, A.M.E.

BOTH the engineer and the amateur often have cause to make or to use condensers of a certain fixed capacity in testing out a new radio circuit. Sometimes they have a number of fixed condensers of unknown capacity on hand.

The condenser is an electrical device which has two or more conducting sheets that are separated by some insulating material (a non-conductor of electricity) in order to store up electrostatic energy. The capacity of such a condenser, which is usually measured in microfarads (mfd.) depends entirely upon the active area of the plates or sheets of conducting material, the distance separating them, and the kind of material (dielectric or insulator) which is used to separate them.

The formula for the capacity of a condenser follows:

$$C = \frac{A\,K\,.0000002248}{T}$$

where

$A =$ the area of the plates in square inches

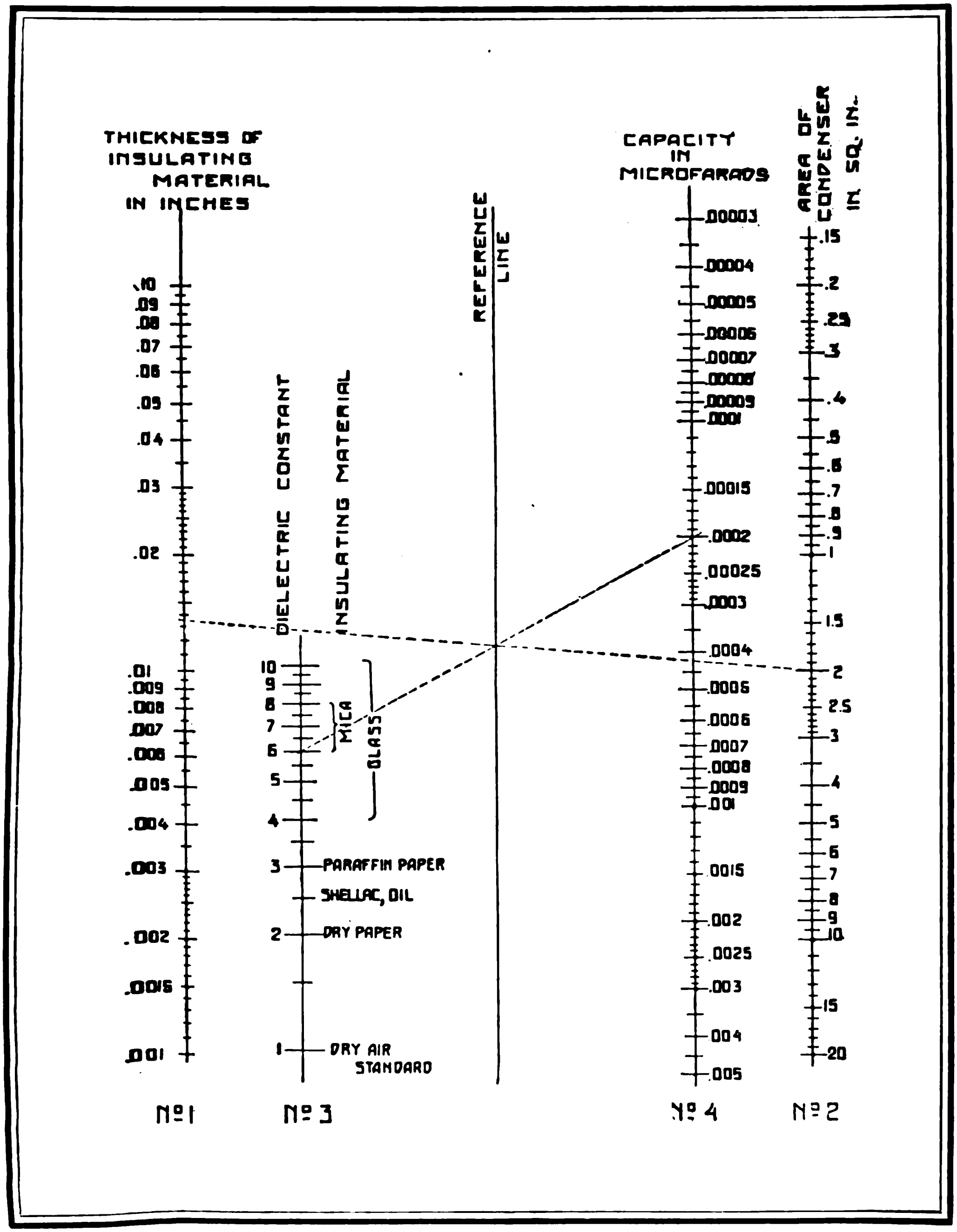
$K =$ the dielectric constant of the insulating material (given below)

$T =$ the thickness of the insulating material, in inches

and

$C =$ the capacity of the condenser in mfds.

The dielectric constants for various materials are:



USE A COMMON RULE ON THIS CHART FOR FINDING OUT THE CAPACITY OF YOUR CONDENSER

FIGURE 1: *To obtain a condenser of a certain capacity, connect the value of capacity on scale No. 4 with the dielectric constant for the kind of insulating material you wish to use, on Scale No. 3, with a straight line. Then connect the thickness of the insulating material you want to use (on scale No. 1) with the point where the first line crosses the reference line, and carry this last line over to scale No. 2. This will give you the correct area for the conducting plates.*

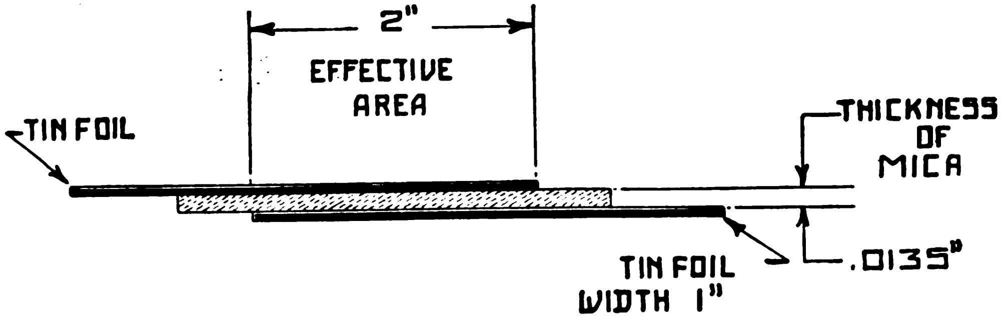


FIGURE 2

This diagram shows how to determine the different dimensions that are necessary to know in using the chart shown in Figure 1, for designing a condenser. Notice that the effective area of the plates is the overlapping area.

Material	*Constant (K.)*
Air (standard)	1
Paper	1.5-2
Paper (Paraffin)	3
Shellac	2.5-3.5
Oil	2.5
Mica	6-8
Glass	4-10

To enable the radio man to determine the capacity of a condenser which is already built, or to determine the size of a condenser which he intends to build that shall have a certain predetermined capacity, the chart in Figure 1 has been prepared, which incorporates the formula given above.

To use the chart to determine the capacity of a condenser, let us consider the example:

A condenser constructed as shown in Figure 2, contains two sheets of tinfoil conductor, which have an effective (overlapping) area of (2 by 1)=2 inches. The thickness of the mica insulator sheet is .0135 inch. Connecting .0135 on scale No. 1, with 2 on scale No. 2, with a ruler, and then connecting the reference point (where this line crosses the reference line) with the dielectric constant for mica (about 6) on scale No. 3 we find the continuation of this line crosses the scale No. 4 at .0002 mfd. which is the capacity of the condenser.

To determine the area of a condenser which will have a certain capacity, the process is reversed.

Example:

To construct a condenser with a capacity of .0002 mfd., using a mica dielectric of .0135 inch thickness, we proceed in the following manner:

Connect, on scale No. 4, the capacity desired (.0002) with the dielectric constant (6) on scale No. 3. Now connect the point of intersection (of this line with the reference line) with the thickness of the dielectric to be used (.0135) and extend this line over to scale 2, which will give the effective (overlapping) area of the plates to be used.

This chart will certainly be a timesaver for the amateur and will give him assurance that he is getting the most out of his experimental circuits by the use of the proper-sized condensers.

Preserve These Hoffman Charts for Reference!

They will save you time and insure accuracy when you build your set. Previous charts have told how to calculate wavelength of antenna circuits, series circuits and circuits in multiple, and how to calculate coil design for obtaining any value of inductance. Following articles will include charts for calculating the characteristics of the antenna, charts for the design of loop antennas, and charts for the design of C. W. transformers.

Traffic Cops *of* the Ether

How "Daddy" Cadmus Checks Up the Good and the Bad Boys of Radio

The task of keeping tab on wavelengths used by transmitting stations and of running down offenders on one hand and of helping amateurs to tune up their sets and to get a license on the other is taking up more and more time of Uncle Sam's radio inspectors. This article tells how one of them facilitates his duties with his ingenious "radio chariot."

By HENRY M. NEELY

UNCLE SAM is a kind and indulgent relative to all the good little boys in radio. But all of the little boys in radio are not good little boys—and Uncle Sam has to keep a watchful eye on the bad ones to see that they do not interfere with the pleasure of the good ones.

It was hard enough in the past to do this when there were only a few amateur sending stations and when they interfered with other amateurs who were usually skilful enough to tune them out. But with millions of beginners hooking up all sorts of inefficient sets to receive the modern broadcast programs and with the beginners even more inefficient than their sets, the amateur with the transmitting station has to comply strictly with all of the laws that Uncle Sam has made or else the inspector in his district begins to get complaints from the neighbors. Then there is trouble for somebody.

The radio inspectors all over the country are getting wrinkled and gray-haired as these complaints come pouring in. Oddly enough, most of these men are old "hard boiled hams" themselves and they agree with the amateur that the fuzzy growl or high-pitched shriek of the dot and dash code is the sweetest music in the world. But they are officials sworn to uphold the law and their personal sympathies have nothing to do with the case. If they find that an amateur against whom complaints have been lodged is exceeding his legal wavelength or is stepping on the gas too hard in the matter of power input or has not even a flirting acquaintance with that charming mystery of radio known as "Logarithmic Decrement," they have to walk in on him, pull back their coat lapel, show their badge and say gruffly, "Will you come quietly or shall I put the bracelets on?"

It remained for the inspector in the Third District to combine his hobby with his duty and thus reduce his worries by about 101½ per cent. Lieut. R. Y. Cadmus, popularly known as "Daddy" Cadmus, lives in Baltimore and has headquarters in the Custom House there. He is the radio daddy of all the good little boys who pound a mean fist from the District of Columbia to Trenton, New Jersey and all over the eastern half of Pennsylvania. The automobile is Cadmus' hobby; checking up on the shortcomings of his numerous radio children is his official duty.

With the rapid growth of amateur stations, he found it a tremendous job to investigate all of the complaints made by the enthusiast of the oatmeal box radiophone against amateur transmitters, because it was necessary to set up a perfectly calibrated receiving set within hearing distance of each station under suspicion. And it is no easy job to shove a wavemeter up against a strange aerial and take your oath as to the accuracy of the result!

Instruments of this kind are heavy and cumbersome to carry around anyhow; the mere problem of transportation is enough to make the average radio inspector quit his job.

So Daddy Cadmus combined his automobiling hobby with his calibrating duty and installed a complete testing station aboard his motor car. This is not a toy by any means, nor is it one of those affairs that are driven around the streets for advertising purposes and that have to be repaired every night to undo the damage done by the jolting of the car during the day.

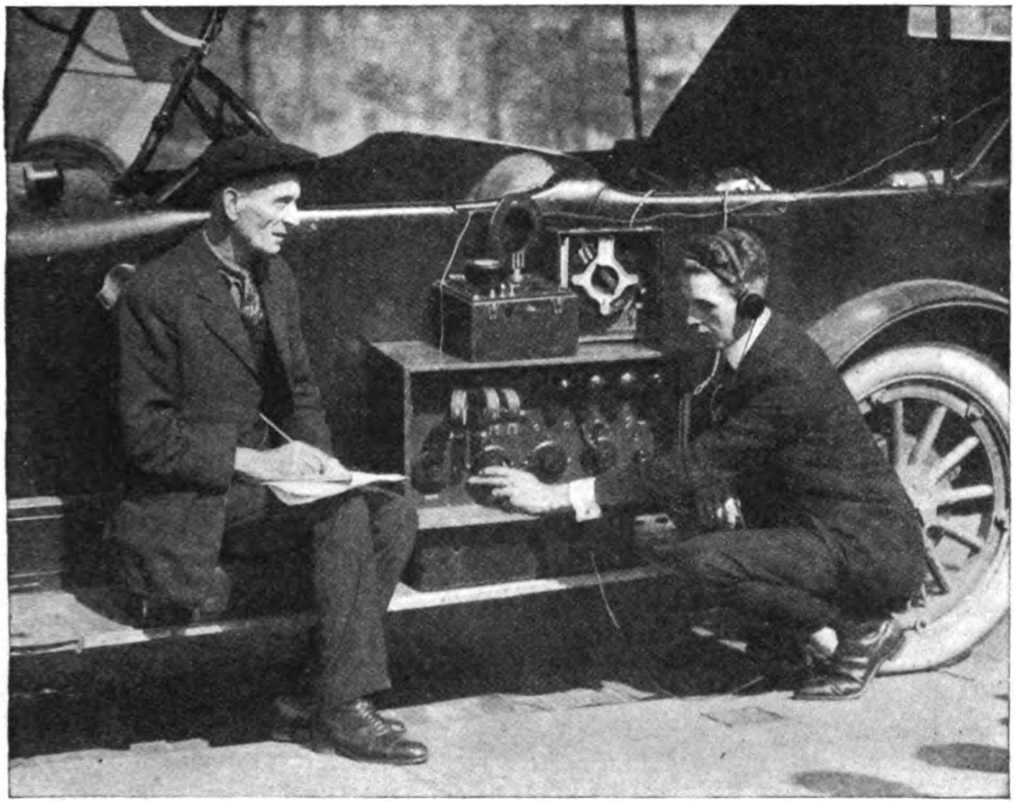
This station on wheels is built like a battleship so far as concerns what engineers call its "factor of safety." It has a miniature four-wire aerial strung between a steel mast on the front and another steel mast on the back, and these masts themselves are supported and braced by specially fitted steel arms that would almost do for bumpers if Daddy Cadmus should choose to try to push a freight car off the track.

On the back seat of the car is mounted a receiving set with a detector and two stages of audio frequency amplification, using the well-known three honeycomb coil circuit for tuning with variable condensers in each circuit.

When he first made this set Daddy Cadmus took it out in the country outside of Baltimore and experimented with it just to see whether it would be possible to get long wavelengths on such a short aerial. He was gratified to find that the big transatlantic stations came in like a ton of bricks on 20,000 meters with the use of 1,500-turn coils.

He then plugged in on the little baby outfits and found that he could get the amateurs; in this way he knew that he had a set that was good for his purpose. It was then merely a matter of placing a wavemeter in resonance and from then on he could read off the wavelengths of any station with a margin of accuracy that was astonishingly minute.

As soon as he had proved the success of his experiment he and his assistant, L. E. Richwien, of Baltimore (who in



HUNTING OVERGROWN WAVELENGTHS

By means of this portable apparatus, Inspector R. Y. Cadmus and his assistant, L. E. Richwien (3XT) traveled about in the Third District and in a little over two weeks checked up as many stations as would normally occupy their time for ten times that period.

his unofficial moments signs off "QTC nil nw OM 73 CUL GN de 3XT"), started on an inspection tour to see how much ground they could cover. There are not many so called "efficiency experts" in business houses who can point to such a saving of time.

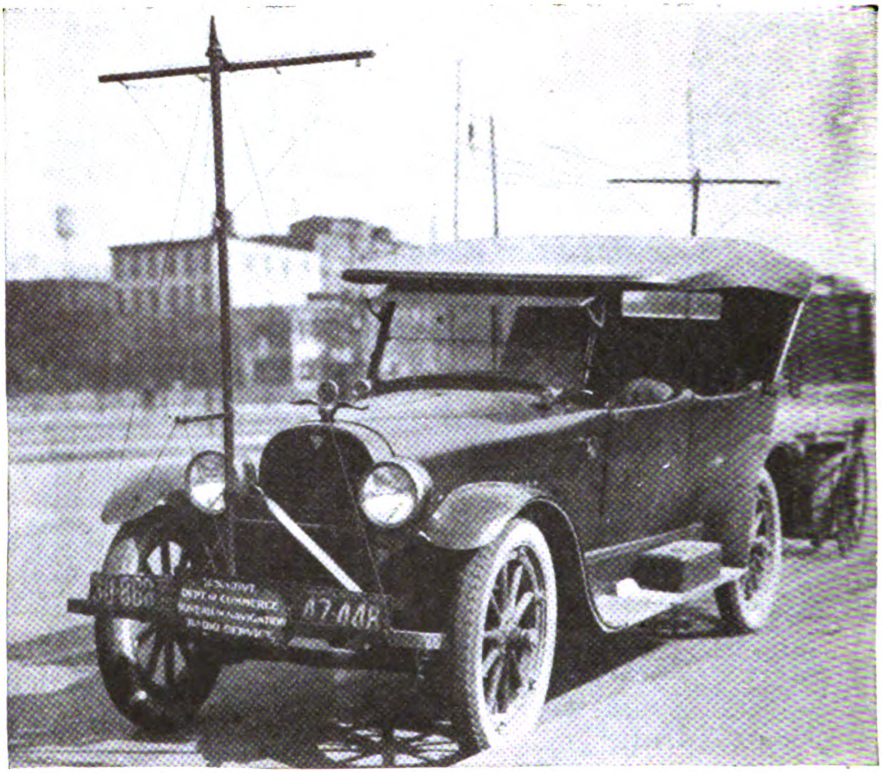
With this traveling station, Daddy Cadmus and Richwien checked up, in a little over two weeks, as many stations as they had been able to check up in between five and six months without it.

Cadmus admits that he did not observe union hours on this expedition. The two men spent their days flying from one station to another, personally inspecting each bit of apparatus; and they spent their nights at some advantageous locality outside of different cities listening in on all of the DX work and all of the plain key pounding going on in the ether about them.

First Richwien would put the receiving set and the wave meter on the running board and wear the phones while Daddy Cadmus stole a few hours' sleep on the back seat; then Daddy Cadmus would relieve him and Richwien would take the inspector's place among the blankets. In seventeen days these two men managed to spend three nights of sleep in their own beds at home.

Who wants to be a radio inspector now?

Although it has nothing to do with this traveling check-up station, Daddy Cadmus had some things to say about radio in general when I saw him on this trip.



THE RADIO SLEUTH ON THE TRAIL

With this essentially serviceable antenna system, the Inspector is enabled to pick up signals from transmitting stations ranging from the greatest transatlantic giants to the smallest of the amateur pygmies.

"Nobody can realize," he said, "the condition of chaos in an inspector's office with the present radio bill still pending before Congress. Every license that we issue now is for three months only and is marked *provisional* because nobody knows what Congress is going to do in the matter of technical requirements for transmitting stations and we cannot give a regular two-year license until the details are determined upon. Consequently we have been giving licenses good for only three months. This would not be so bad if we were permitted at the end of that time merely to write the word *Extended* across the face of the license. But we are not. We must forward new application blanks to each station and each station must go through all of the detail of filling out a complete description of its set, in duplicate, while we have to go all through once more the process of entering and filing and taking the oath and stamping and everything connected with the issuing of a new license. This applies not only to the amateur stations but to the broadcasting stations as well, so you can imagine the kind of job we have. In my district alone there are three clerks who have to work overtime every day on nothing but this matter of licenses.

"The past few months, remarkably enough, have shown a decrease of something like 40 per cent in the number of amateur transmitting stations that have applied for licenses, either new ones or renewals. This might seem to indicate that the interest in radio is dying out but my investigations show that the very contrary condition is the cause of it.

"Prior to a year ago, Sonny could lock

himself up in his own room and spend the whole night in perfect bliss 'chewing the fat' with his fellow hams within hearing distance of his spark gap. Father was probably away at the club and Mother was in the kitchen washing the dinner dishes and Sister was probably fox-trotting around the parlor with a dude in a high collar just home from college.

"But is Sonny allowed to have any such joyous evenings by himself these days? He is not.

"As soon as the good radio weather came in in the fall, Father stayed home from the club and Mother let the dinner dishes go until next morning and Sister brought the dude upstairs and introduced him to the family and the whole crowd took Sonny's favorite chairs in Sonny's room and insisted on Sonny tuning in on the nearest 360-meter broadcasting station and putting it on the loudspeaker. By the time the concert was over it was time for Sonny and everybody else to go to bed.

"Then they heard about improvements that could be put on these receiving sets and they had to have radio frequency and audio frequency amplification and the money that Sonny might have put in a new motor generator or a 500-cycle rotary gap went for apparatus that would make enough noise so that "Uncle," two blocks away, could hear the howling of the oscillating bulbs even if he could not make out any of the music.

"After about six months of this, Sonny simply shuts down his set in disgust because Father and Mother and Sister and the high-collared dude have all learned to twist the knobs, and Sonny is lucky if he is allowed in the room at all. Consequently when his transmitting license expires it is not worth while for him to apply for a renewal. All of the apparatus in his old set has gotten rusty or is falling apart and the money that he might have used to repair it has been spent on the family receiving set."

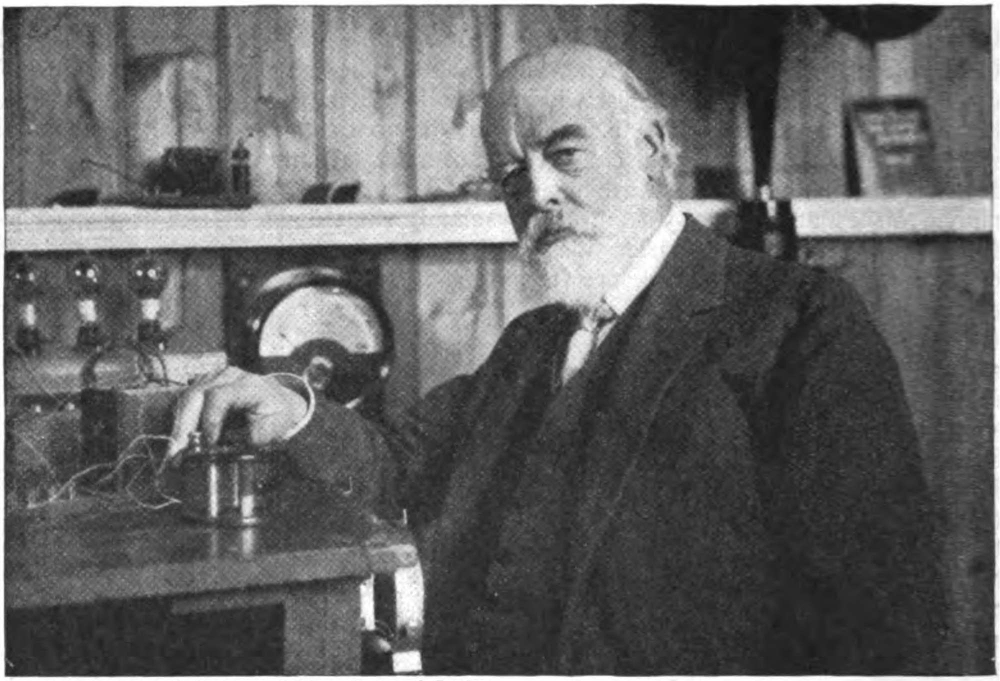
That does not sound as if Daddy Cadmus' idea of a perfect evening was listening to a broadcast concert, does it? Well it is not.

Daddy Cadmus is a "hard-boiled ham" himself and there is no music in the world to him quite so sweet as a good, clean fist, shooting code at something like 25 to 30 words a minute on a 500-cycle note.

Maybe that is an old-fashioned view to take of radio but there are a lot of us old timers, fast dwindling into a pathetic minority, who still feel that way about it.

How to Use Your Radio Set on Your Vacation

IN *the next number of* POPULAR RADIO *Mr. William F. Crosby will tell in specific and helpful detail just how to rig up your receiver in your camp by the water or in the woods, and how to install it on your motor car. The author is one of the most experienced men in the country on installations of this kind, and his article will be fully illustrated not only with numerous hook-up diagrams but also with photographs of actual—and successful—vacation sets in practical use.*



From a photograph made for POPULAR RADIO by Hoppé, London

A SCIENTIST WHO DEMONSTRATES HIS THEORIES BY PRACTICAL EXPERIMENT

The importance of coils in both receiving and transmitting sets can hardly be overestimated. In this article the distinguished English scientist, Sir Oliver Lodge, gives the results of his laboratory investigations that are of incalculable value to the radio amateur.

HOW TO GET THE MAXIMUM INDUCTANCE IN YOUR COILS

Third of a Series of Articles Written for POPULAR RADIO by—

SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE conditions under which a coil can have maximum self-induction (inductance) for a given length of wire seem to have been laid down by the great mathematician Gauss, in or about 1865, but in what form that can have been then done I do not know. Anyhow, Clerk Maxwell, in his great treatise published in 1873 gives a number of complete formulas for inductance, and clearly specifies the condition for its maximum. He evidently paid great attention to the subject of mutual and self-inductance, probably in connection with his determination of the absolute value of the ohm (or "British Association Unit," as it used to be called then).

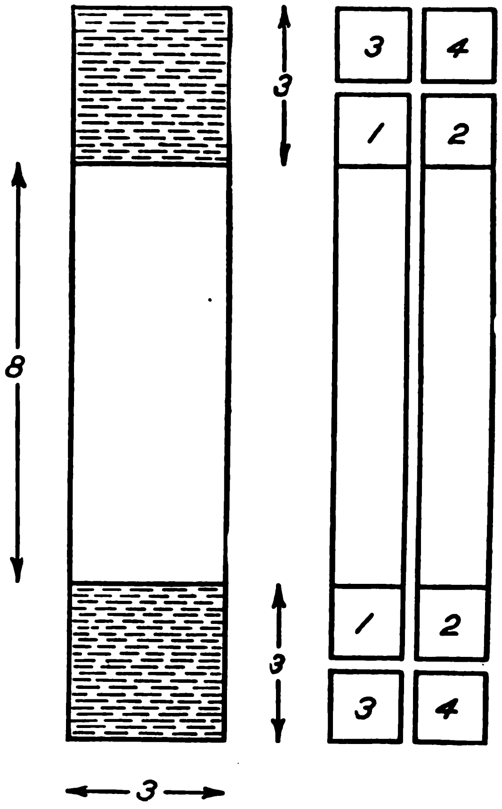
The first condition is that the winding should be as compact as possible, so as to bring every part of the wire as close as possible to every other part, so that as many as possible of the lines of force, due to each, may thread the others. That will be achieved by making the cross section of the winding on the coil either round or square, not oval or oblong. That much is obvious, because that is the most compact shape: but it is not at all obvious how big the diameter of the coil should be in proportion to the size of the channel which contains the winding. That is what has to be worked out mathematically.

Although the working out may be considered complex, the result can be stated with great ease. Taking the channel for the wire as square, the outside diameter of the coil must bear, to the inside diameter, the ratio 47/27, which for all practical purposes is the same as 7/4, or 1¾. Hence the shape of the coil which gives maximum self-induction is as drawn to scale in the diagram (Figure 1), the breadth and depth of the winding being 3, the internal diameter 8, and the external diameter 14. For the present, we may take that as granted; and in this shape, no matter whether the turns are packed close together or not, the coils employed in radio ought to be wound (though they seldom are). That is the best and most efficient shape; and by adhering to this shape—other things being equal—the deleterious capacity and resistance in the coil are reduced to a minimum.

It need not be supposed that the shape must be very *precisely* adhered to. It is a common property of maximums and minimums that a slight fluctuation on either side makes but a small difference. This shape is the ideal to aim at, but some variation is allowable.

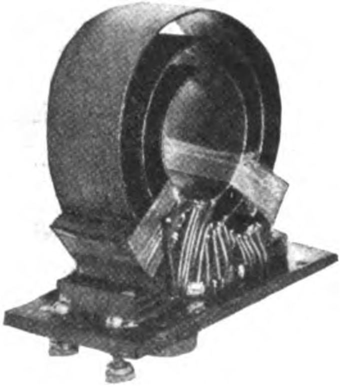
For instance, suppose (having made one coil), we want to put another alongside of it, and in series with it; the inductance will be immensely increased by an amount which is quite well known if the positions are given. But the shape will no longer be the best. Still, the difference is not very important; and something like the best shape can be restored by having four coils instead of two, and putting them in pairs side by side, with one pair big enough to fit over the other, as indicated in the diagram (Figure 1). Numbering the four coils 1, 2, 3, 4, it will be best to connect them together in that order, so that the extremities of the wire, at which the greatest difference of potential will occur, are as far separated from each other as possible. The connection 1, 2, 4/3, or 1, 3, 4, 2, is slightly less desirable.

The effect of putting one coil outside of another, instead of side by side, is that the mean radius of the whole winding is increased somewhat: otherwise the expression for the inductance is the same in the two cases. It is as broad as it is long, so to speak. Or rather, whether the length exceeds the breadth, or the breadth exceeds the length, makes no difference. That is not obvious, but so it



THE BEST SHAPE FOR COILS

FIGURE 1—*At the left is shown the dimensions for a single coil; at the right is shown the arrangement of a number of coils that can be connected in series, and that will still keep the best shape for inductance. For maximum results and to insure the lowest distributed capacity they should be connected as they are numbered: 1, 2, 3, 4.*



A THREE-LAYER COIL

This coil is tapped so that various inductance values may be used to facilitate changes in wavelengths ranging from 150 meters up to 3,000 meters. It will be noticed that this coil complies rather closely with the maximum inductance conditions so far as its shape is concerned.

A FIGURE-EIGHT COIL

This special type of coil has the wires run in the form of a figure eight. It is usually used in cases when some form of loosely coupled coil is suitable. The coupling between two such coils may be varied by simply revolving one of them upon its axis throughout a revolution of ninety degrees.

A HONEYCOMB COIL

This coil, which is widely used here in America, adheres closely to the ideal for maximum inductance. With this type of apparatus it is easy to obtain fairly close coupling by placing two coils side by side. The coupling is varied merely by drawing the coils farther apart.

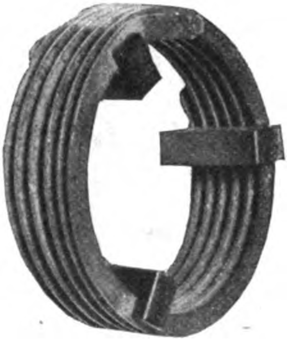
comes out from the formula, which is symmetrical as regards length and breadth of cross section.

The advantage of a combination of coils, like this, is that it enables the wavelength to be easily changed; that is to say, it enables a coil to be selected which shall give approximately the order of wavelength required, fine adjustments being done by means of supplementary variable condensers, or by a separate variable inductance, or both. But we will not trouble about these tuning details, which are quite well known and understood.

Although I have emphasized the value of a maximum inductance shape, such considerations must not be allowed to override practical convenience; and, instead of packing coils into a square section, it is usually much more convenient

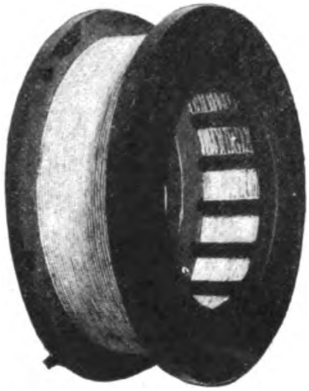
A TRANSMITTING HELIX

This type of coil is made of edgewise-wound copper strip instead of wire. The coil is held in shape by means of insulating spacer-rods which are slotted to fit the copper strip. The main advantage of this form of coil for transmitting lies in the large conductive surface area which is offered to the passing currents.



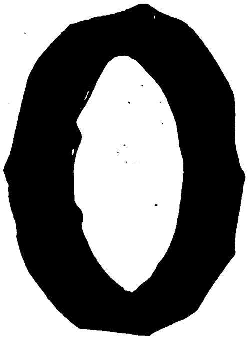
A BANK-WOUND COIL

In this coil the litzendracht wire is wound around a sort of circular ladder. This formation eliminates a large amount of useless insulating material from within the magnetic field of the winding, and cuts down the "hysterisis" losses in the insulation.



ANOTHER FORM OF MULTIPLE-LAYER COIL

Each layer of the winding of this coil is separated from the next consecutive layer by a snake-like layer of wire which is interposed between the main layers. All of the wire in the coil is connected in the circuit, however, which makes this coil exceptionally efficient.



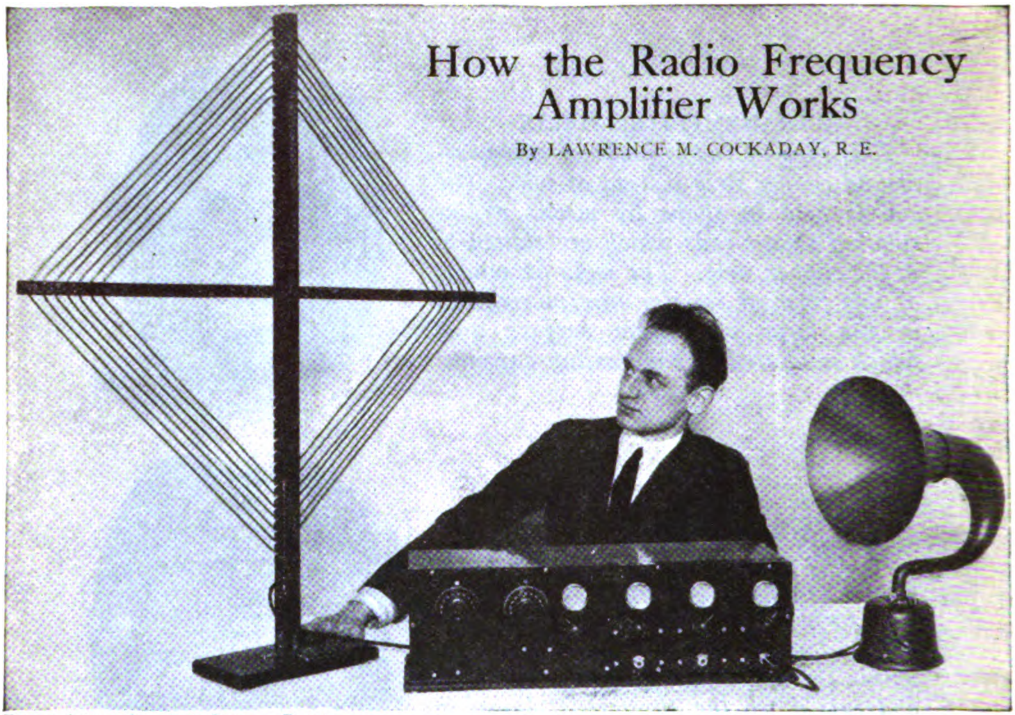
to arrange them either side by side, or one outside the other. That is to say, to arrange them so as to form either a cylinder or a disc. And again, such an arrangement *has* an advantage; for, though the inductance will be less than it might be with a given length of wire, the terminals are thereby kept far apart, and the capacity is therefore also diminished. Hence I do not propose to consider any arrangement except one or other of these plans for the construction of multiple coils.

When we are dealing with the single coil, however, there is no question but that the best shape is as stated before, that is to say, one with an external diameter of 14, and an internal diameter of 8.

Further details about this we will consider in a succeeding article.

How the Radio Frequency Amplifier Works

By LAWRENCE M. COCKADAY, R.E.



From a photograph made for POPULAR RADIO

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—No. 9

A beginner's first vacuum tube set usually includes simply a tuner and one vacuum tube as a detector. When he has mastered this set, his next thoughts are directed toward methods for amplifying the received signals; at this point it is always a question in his mind whether to use radio or audio frequency amplification. This article (see also "How the Audio Frequency Amplifier Works" in POPULAR RADIO *for February, 1923) tells not only how the two methods work but also their particular uses and advantages.*

IN the last article of this series we stated that cascade amplification of radio signals could be divided into two classes, as follows:

First, audio frequency amplification.

Second, radio frequency amplification.

Audio frequency amplification is cascade amplification of the rectified impulses which are flowing in the plate circuit of the detector tube. These impulses are of an audible frequency and the successive stages of amplification are coupled together with "audio frequency amplifying transformers," which step up the voltage of the audio frequency impulses and supply them to the grid circuit of the next tube.

Radio frequency amplification is cascade amplification of the impulses of radio frequency current received from the antenna circuit of a receiver before they have been rectified by the detector tube. The successive stages are coupled together with radio frequency transformers.

In the article "How the Audio Frequency Amplifier Works" in the February issue of this magazine, we studied the functioning of this type of apparatus fairly thoroughly; those readers who have read this article should understand its fundamentals clearly.

Before we take up the subject of how the radio frequency amplifier works, however, let us learn of one of the disadvantages of audio frequency amplification.

The detector tube receives radio frequency oscillations and turns them into pulses of direct current. But *the impulses must be of a certain strength before the detector will respond to them.*

Let us consider the case of a receiving set that employs a vacuum tube detector and two stages of audio frequency amplification. The set is installed in a city. Signals from stations located in the city were detected and received with such volume as to be unbearable. This is because the detector delivered a fairly large impulse to the amplifiers and they further strengthened them to an enormous value. Signals from stations, say 500 miles away, were only just audible with the detector alone, but when the amplifiers were used they were comfortably audible; the amplifiers took the feeble current from the detector and strengthened it. Signals from across the other side of the country, however, were too weak to be detected by the detector tube and so the amplifiers were supplied with no current; thus no signal was heard.

This difficulty of the audio amplifier may be summed up in the following statement.

The audio frequency amplifier will not function on a signal unless the signal is of sufficient strength to operate the detector tube and thus supply an audio impulse to the amplifier. This is true no matter how many stages of amplification are used. Audio frequency amplification has its use, however, as it is the most efficient method for getting a loud signal when the initial signal is strong enough to operate the detector tube.

Radio frequency, on the other hand, has just the opposite characteristics; by its use, weak distant signals are amplified, but they cannot be increased by this method to a value strong enough to operate a loudspeaker satisfactorily. Radio frequency amplification strengthens the feeble oscillations received from the antenna circuit until they are strong enough to be detected by the vacuum tube detector.

In other words radio frequency amplification takes place *before* the signals are rectified by the detector and audio frequency amplification takes place *after* they are so rectified.

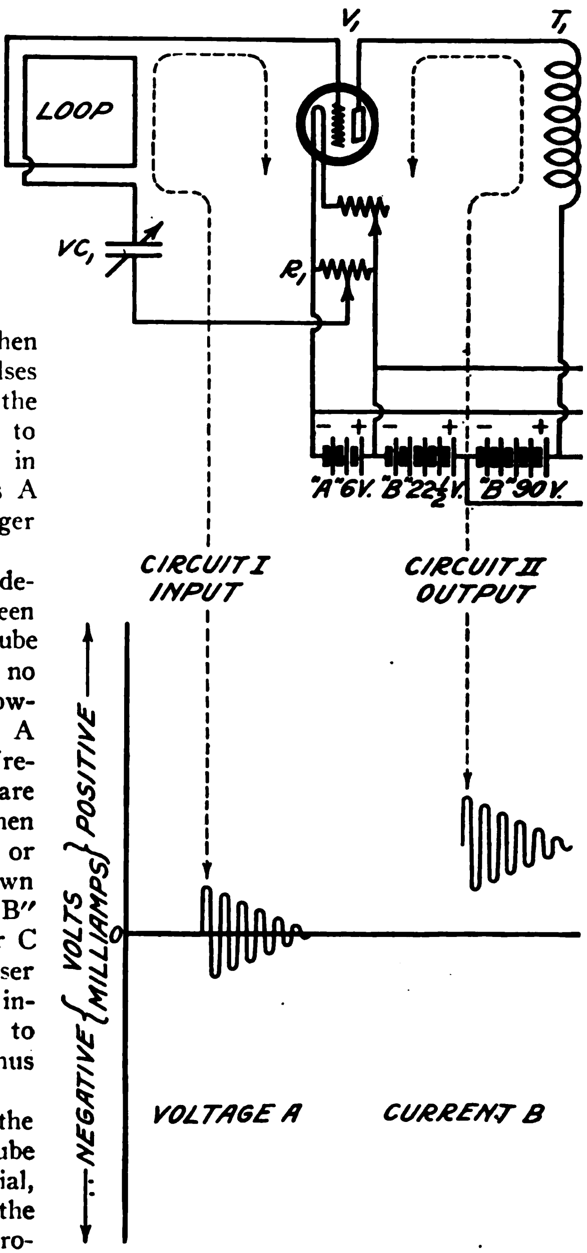
So much for the general explanation. Let us now see how the radio amplifier works.

In the diagram (Figure 1) is shown a conventional circuit with two stages of radio frequency amplification, and a vacuum tube detector, that employs a loop antenna. The tuning elements consist of the loop inductance and the variable condenser VC. The first stage of amplification consists of the tube V1; this is coupled to the second stage tube V2 by means of the radio frequency amplifying transformer T1. The second stage is coupled to the detector tube V3 by means of a second transformer T2, which is started by a condenser VC_2, and which supplies the amplified radio frequency impulses to the detector tube for rectification.

A weak impulse (much too feeble to operate a detector tube, let us say) is received by the loop and tuned by the condenser VCI. This high frequency impulse flows through the input circuit I and impresses a tiny voltage wave A on the grid of the amplifier tube V1. The relay action of the tube reproduces this wave form in its plate circuit II and causes a current B to flow through the primary winding of the transformer T1. (This type of transformer is unlike the audio frequency transformer in that it has an air core and readily passes high frequency currents through its windings, whereas the audio transformer has an iron core and passes only low frequency currents.) The voltage of the impulses is stepped up by the transformer T1, and supplied by its secondary winding to the grid of the tube V2 in circuit No. III. This voltage is shown at A′; by comparison with A it will be seen that it has been increased considerably. The tube V2 then responds to this voltage A′ and a current wave B′ flows in its plate circuit IV, through the primary winding

FIGURE 1

This diagram and chart show how the successive stages of amplification increase the minute voltages and currents of radio frequency energy until even the weakest signals are reinforced enough to be detected by the vacuum tube detector. This amplification is done BEFORE *the signals are detected.*



of the transformer T2. Comparison of B and B^1 will show a great increase in the current value. The transformer T2 then steps up the voltage of the impulses and impresses a voltage A″ on the grid condenser GC which passes it to the grid of the detector tube V3 in circuit No. V. Compare Voltages A and A″. A″ is very much stronger than A.

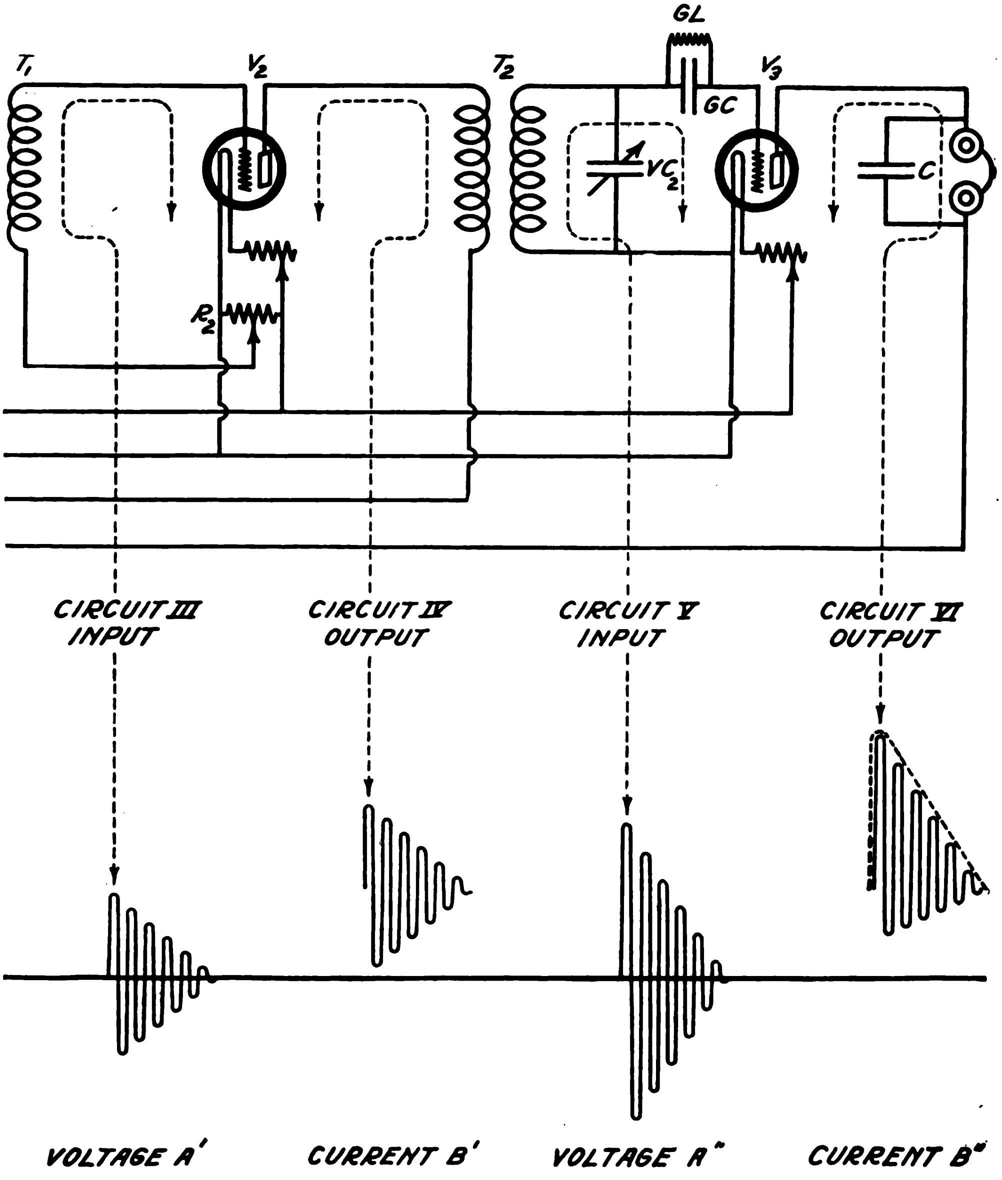
If A had been supplied to the detector tube direct, it would have been too weak to be detected by the tube V3 and there would have been no response in the plate circuit VI. However, the weak impulses shown at A have been amplified by the radio frequency amplifier until they are strengthened as shown at A″, when the tube V3 is able to detect them, or in other words, rectify them as shown at B″ in circuit VI. This current B″ flows through the bypass condenser C and the voltages on the condenser cause a low frequency current, as indicated by the dotted lines in B″, to flow through the telephones T thus producing audible sounds.

It must be borne in mind that the impulses on the grid of each tube oscillate about its free grid potential, and to secure maximum results the potentiometers R1 and R2 are provided as means for adjusting this free grid potential with respect to the filament.

By means of radio frequency amplification, then, distant signals may be easily heard without the use of audio frequency amplifiers, that could never be heard with any number of stages of audio frequency amplification if radio frequency amplification were *not* used to strengthen them.

This same sensitivity of the radio frequency amplifier makes it suitable for use with the loop antenna, which collects only an extremely small amount of energy, where the audio frequency amplifier *alone* would fail.

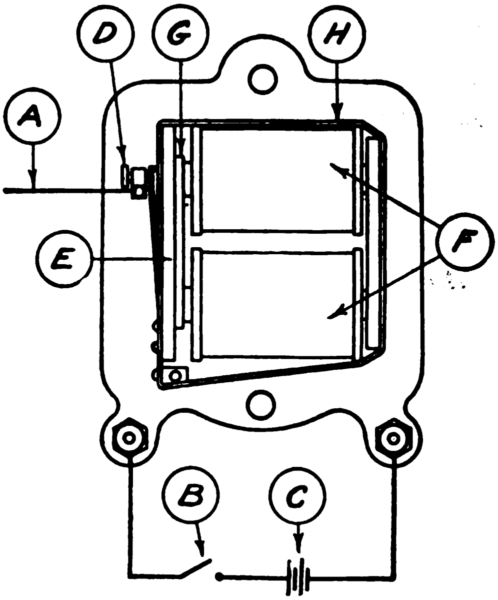
The use of radio frequency amplifica-



tion with a loop antenna for building up the strength of the feeble impulses so that the detector tubes can detect them, combined with the use of the audio frequency amplifier to increase these audible impulses to sufficient strength to operate a loudspeaker, makes an ideal set for listening to broadcasting. And not the least of its virtues is the fact that it may be assembled complete in a case similar to that of a phonograph, with batteries, tubes, loop and all; no outside connections are necessary.

In summing up, the use of audio frequency amplification is limited to signals which are strong enough to be detected, when this method will increase the volume tremendously. The use of radio frequency amplification is for increasing the strength of feeble impulses that are not strong enough for a detector to pick up alone.

THE PARTS OF THE BUZZER TEST ARE—*A is the wire that should be connected to the ground wire of the receiving set; B is a simple push button switch; C is a couple of dry batteries; D is the adjusting set screw; E is the armature; F shows the magnets; G is a small piece of cardboard, and H is a rubber band.*



How to Make a Simple Buzzer Test at Home

By RICHARD LORD

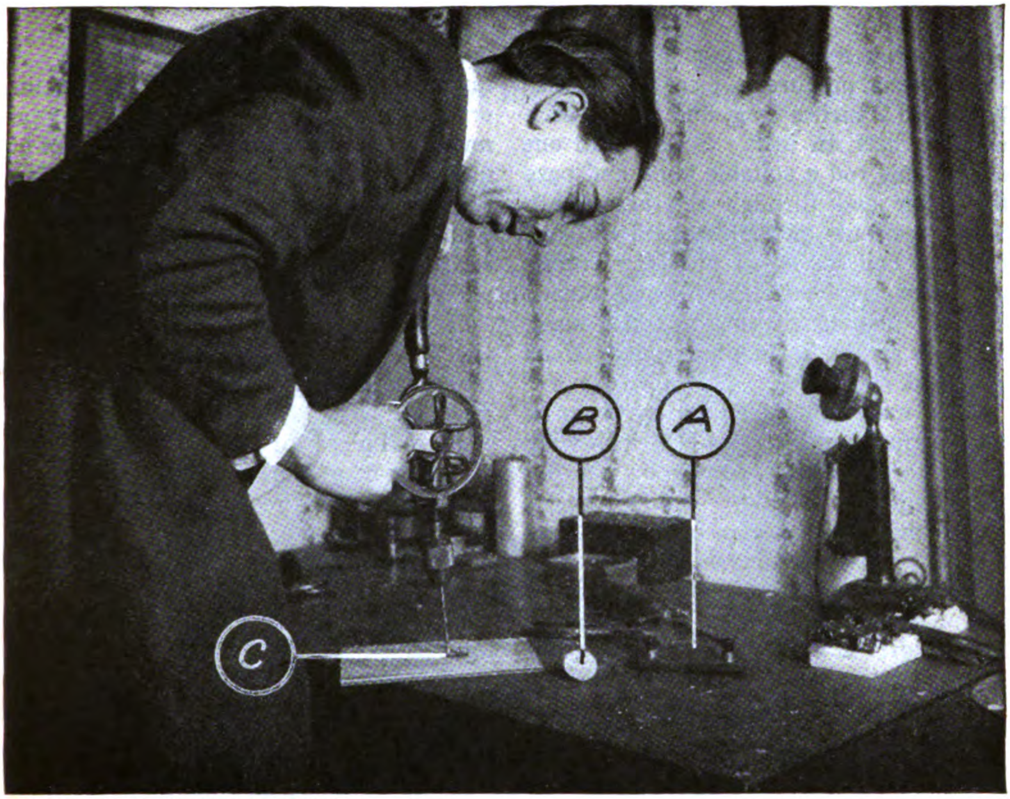
THE amateur who has had trouble with his crystal detector will welcome this word of practical advice from an experienced New Jersey fan; it tells how the trouble can be eliminated:

Aside from the fact that the buzzer test aids the amateur considerably in locating sensitive spots on a crystal, it is a real help in preventing the fading out of signals; merely by pressing the test buzzer switch the signals may be brought back to their former strength. One theory offered in explanation of this phenomenon is that a slight film of oxidation forms between the catwhisker and the crystal, thereby reducing the strength of the signal. The pulsations of current from the test buzzer seem to break down this film and to permit better contact.

For the dyed-in-the-wool fan who must have the best of everything, there is on the market a high frequency buzzer which gives an especially clear, even, and pleasing note in the phones. However, the cost of this buzzer is beyond the reach of some of us; for these an ordinary buzzer can be made to serve admirably. A piece of cardboard or folded paper placed between the heavy iron armature and the contact spring (as shown in the diagram on this page) produces a fairly high and even tone. A rubber band placed as indicated in the diagram will also be found advantageous in obtaining a high note. After the buzzer is obtained it is connected in series with some kind of a switch, and one or two dry cells. One of the most convenient switches, in the writer's estimation, is nothing more than a simple electric push button.

An examination of the buzzer discloses a little adjustable screw, which makes contact with the vibrating armature. To this one end of a wire is fastened; the other end is connected to the ground wire of the receiving set. In some types of loose-coupled sets it will be found that this type of connection will not give satisfactory results; if such is the case, connect the latter end of the wire directly to one side of the detector, rather than to the ground lead. This connection will invariably work.

It is advisable to place the buzzer in a small box, so as to eliminate mechanical noises as far as possible. Fill the box half full of absorbent cotton and place the buzzer on this cotton. Then fill the box entirely full of cotton and put the cover on, leaving, of course, the leads projecting out. This box may then be suspended from under the table; it will be found practically impossible to hear the buzzer while in operation.



From a photograph made for POPULAR RADIO

This detector with a light spring adjustment, which uses either galena or iron pyrites, consists of (A) the base and adjusting arm, (B) the cup which holds the crystal, and (C) the upright upon which the cup is mounted.

How to Make a Light-Contact Detector

By LEROY WESTERN

EVERY true experimenter in radio at some time or other has used a crystal detector, for as a beginner he started out with a crystal receiving set. Those who are now starting out on their radio experiments will be interested in the detector here described; the time spent in its construction will be fully compensated for by the ease with which it may be adjusted.

The first consideration is the crystal. There are many kinds which can be used in connection with this detector, such as galena, iron pyrites (ferron) and silicon, to mention but a few. Galena is probably the best known and the most frequently used, but a little experimenting will show the amateur that some of the others are just as good, certain ones in some ways better. For instance, sensitive specimens of iron pyrites, while considerably more difficult to find than sensitive galena, give equal results and retain their sensitiveness for a long period of time. This crystal is generally used with a stiff phosphor bronze spring, the end of which is pointed.

In the construction of the detector first select a base of hard wood, or better still, hard rubber or bakelite, 4 inches long by 2½ inches wide. Drill four holes in this base, as shown in the diagram. Get a brass ball ¼ inch in diameter; drill a hole through the center of it which will make a snug fit for a ⅛-inch brass rod. Next procure a piece of ⅛-inch brass rod 2 inches long, and thread each end for half an inch. Screw onto one end of this rod a suitable knob and pass the other end through the brass ball. Screw two nuts on the threaded end and fasten a coil spring of phosphor-bronze wire between them as shown. A standard for holding the ball is then made of brass in the form of a square U as indicated.

Now make another standard from a brass strip ⅛ inch thick by ½ inch wide in the form of an L to support the detector cup.

For the detector cup obtain a brass cup, 1¾ inches in diameter, either with or without a mounting screw. If the cup has no mounting screw it will be necessary to drill a hole in the center of the cup and pass the screw through it. A quantity of soft metal for mounting the crystal may be made by dissolving as much tin foil as possible in one ounce of mercury. Knead the mass together thoroughly and heat. When it becomes molten, pour it into the cup and press several crystals of various kinds into its surface.

It is important not to heat the metal any more than is necessary to melt it, as otherwise injury to the crystals may result.

Several pieces of various kinds of mineral may be mounted in the detector cup and their various receiving qualities thoroughly tested against each other. A phosphor-bronze wire spring will serve for most types of crystal, but a gold wire is superior as its point will not easily oxidize.

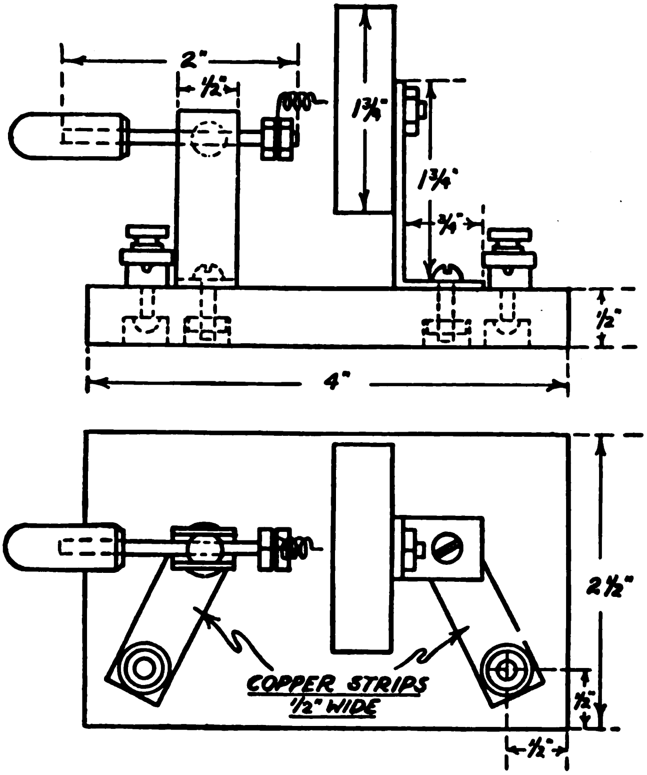


FIGURE 1
This diagram gives the side view (at top) and the top view (at bottom), together with the dimensions of parts of the detector.

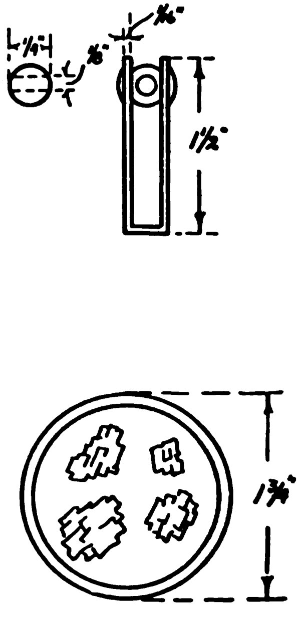


FIGURE 2
This diagram shows the dimensions for the universal joint of the adjustment arm (at top) and the manner of mounting the crystals (at bottom).

> ¶ I consider this Four-Circuit Tuner the most important contribution to the equipment of the radio amateur since the invention of the Super-Regenerative Set.
>
> —Editor

From a photograph made for Popular Radio

The set as it appears in actual use—small enough to keep in a bureau drawer. The demonstrator is the inventor, Laurence M. Cockaday (2XK).

HOW TO BUILD THE NEW FOUR-CIRCUIT TUNER

A new and unusual development in vacuum tube control circuits that is exceedingly selective, simple to operate, highly sensitive (it has a verified C. W. range of 3,200 miles and a telephone range of 2,400 miles)—and that Can Be Built for Less Than $40.00!

By the TECHNICAL EDITOR

THE ideal receiving set should have the following five qualifications if it is to meet the needs of the discriminating radio amateur:

A—absolute elimination of interference;

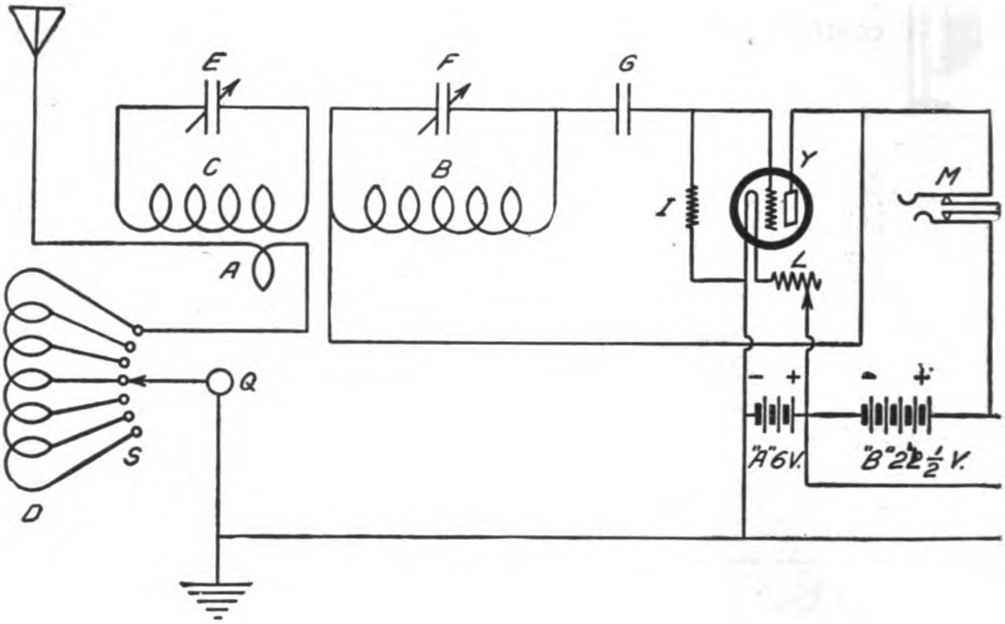
B—unlimited distance range;

C—ease of tuning;

D—truthful reproduction;

E—low cost.

A, B, and C are dependent upon the method of tuning used and the system of



detection. D and E depend more closely upon the type of amplification that is used.

In designing this set we have had these goals in view.

First, therefore, we have determined to use extremely loose coupling to insure the quality A; looser, in fact, than used in any other type of receiver. The step-up voltage ratio of the receiving transformer is 65 to 1. This insures an extremely high grid voltage even from weak signals.

Second, to insure a maximum distance range, and at the same time secure simplicity of tuning, and to hold the cost of construction to a minimum, we have decided to use the regenerative method of amplification as the closest approach to the ideal yet disclosed.

The main shortcomings of the standard regenerative circuit are well known; they may be summarized as follows:

a. A change in wavelength makes necessary a change in the regenerative control to keep the regeneration at a maximum.
b. It is extremely difficult to keep the circuits "stable," so that they will stay at the maximum amplification point. This is due to the fact that changes in the constants in the antenna circuit react on the grid circuit and throw the circuits in and out of resonance so that they oscillate for a few seconds and then cease, causing signals to come in strong for a while and then to die out, and also causing squealing at intervals.

Third, therefore, we have chosen a more simple method for controlling regeneration; it consists of an inductively-coupled stabilizer circuit whose function it is to vary the effective A. C. resistance of the grid circuit of our tuner. This circuit is electrically isolated from all the other circuits in the receiver, but it is placed directly within the magnetic field surrounding the grid coil. It consists of a low-resistance coil shunted by a variable condenser which when it is rotated varies the reaction between the grid circuit and its own circuit.

It is well known that the vacuum tube in a circuit will produce sustained oscillations when the negative resistance of the system equals the positive resistance of the system. The standard regenerator accomplishes this result by varying the negative resistance upward to the correct value.

This new circuit we have evolved, however, accomplishes the result by varying the positive resistance, downward, to the correct value. In the new method

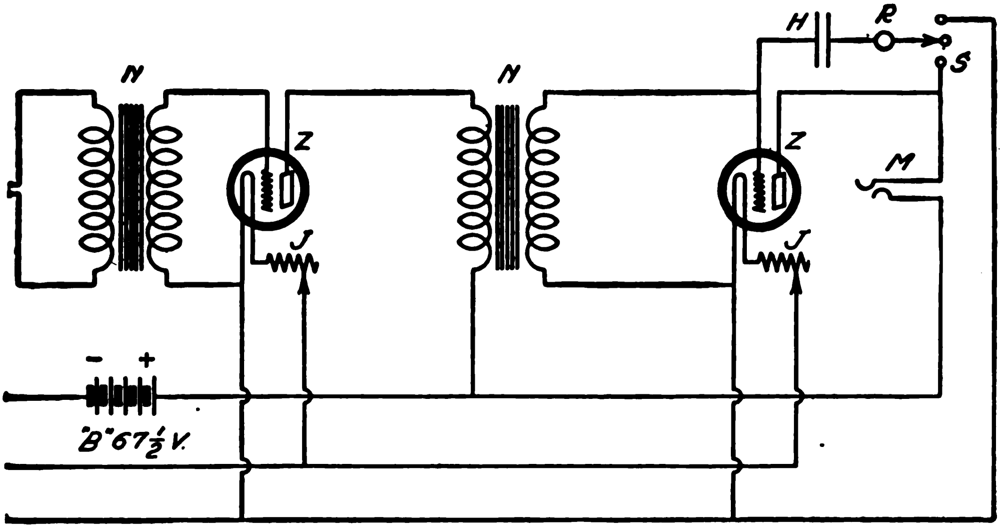
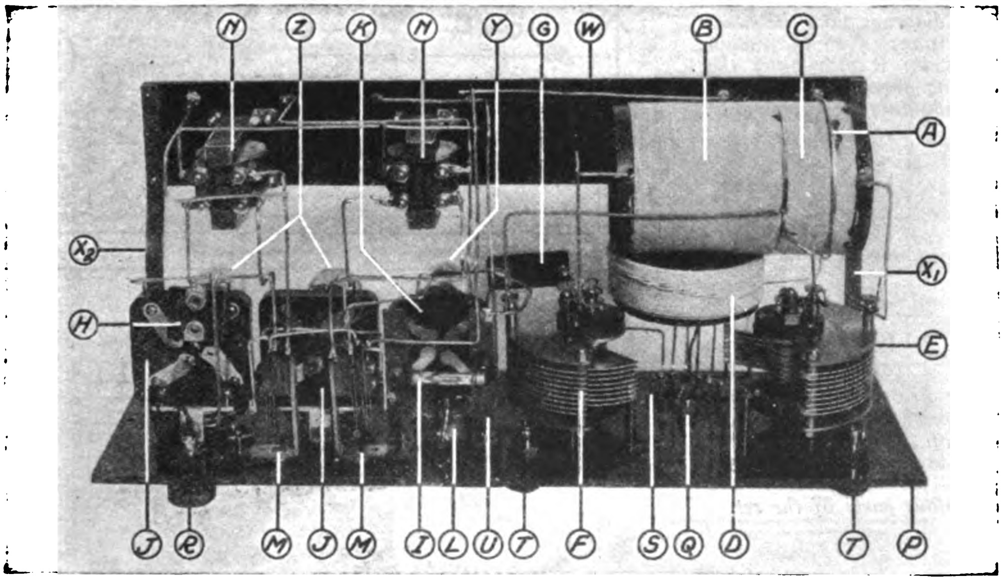


DIAGRAM OF THE FOUR-CIRCUIT TUNER

FIGURE 1: *Here are shown the exact electrical connections for the apparatus used in the new circuit; the parts are designated by the same letters that appear in the text.*



AN INSIDE VIEW OF THE RECEIVER

FIGURE 2: *This picture gives the prospective builder of the Four-Circuit Tuner a clear idea of how the instruments should be arranged in the proper positions. Notice that all of the inductances and transformers are placed well to the rear of the set, so that body capacity is eliminated while the set is being tuned. The mechanical drawings on the following pages give in greater detail the proper spacings and positions of the instruments.*

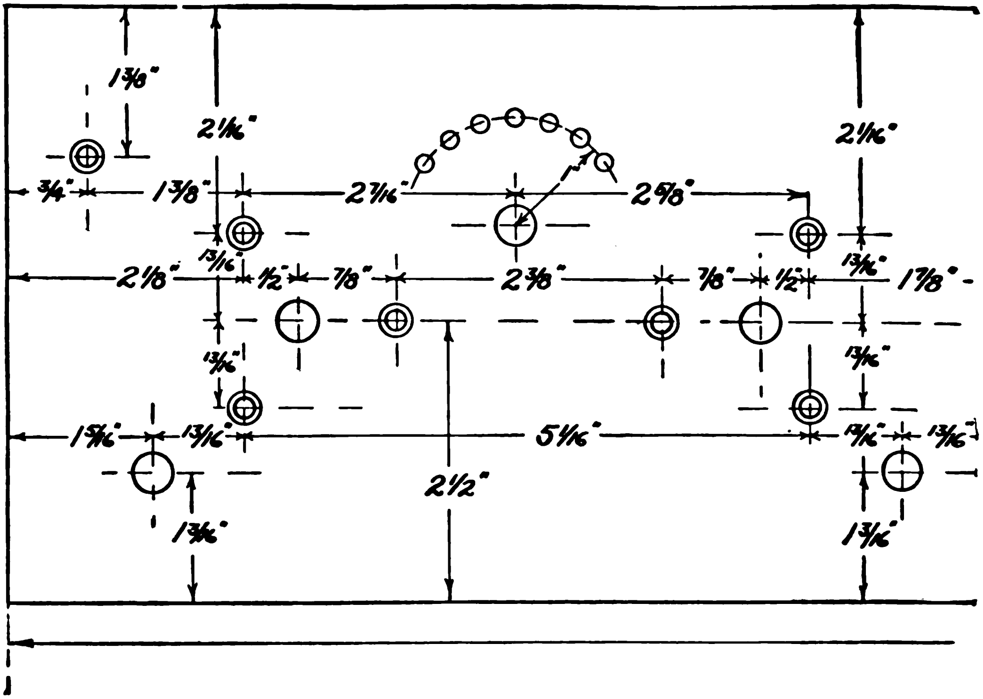


FIGURE 3
(above)
This diagram gives the exact dimensions for the main panel P; it also gives the drilling details for the holes for mounting the instruments.

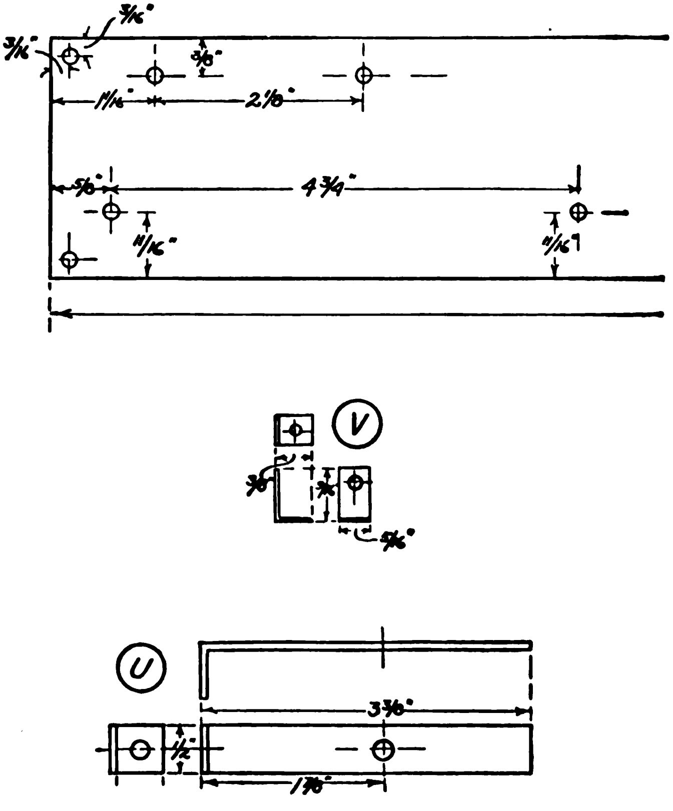
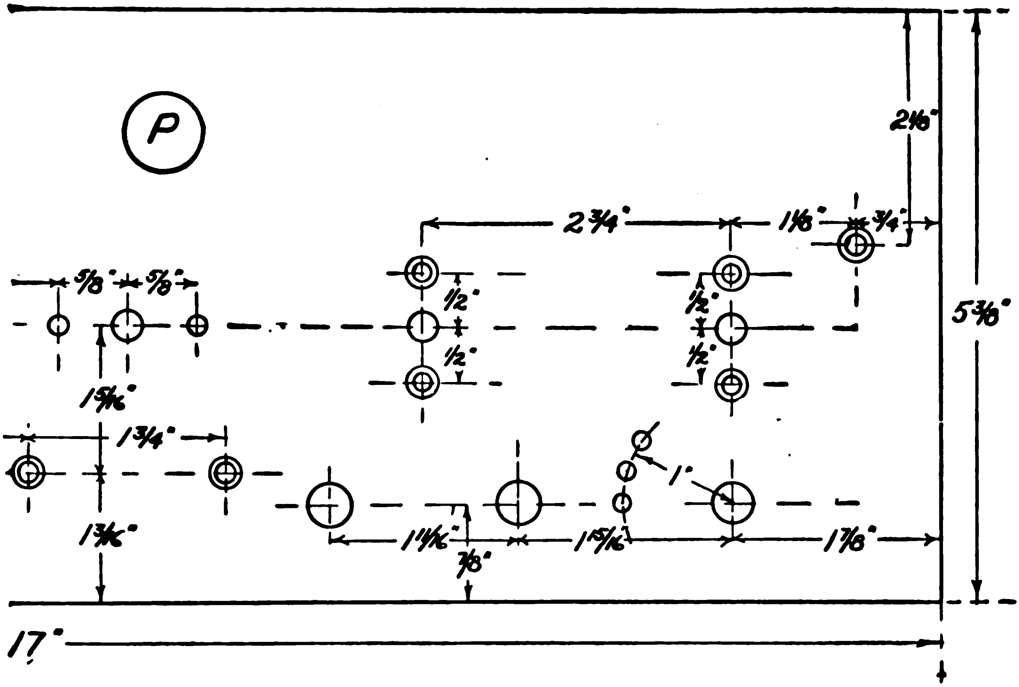
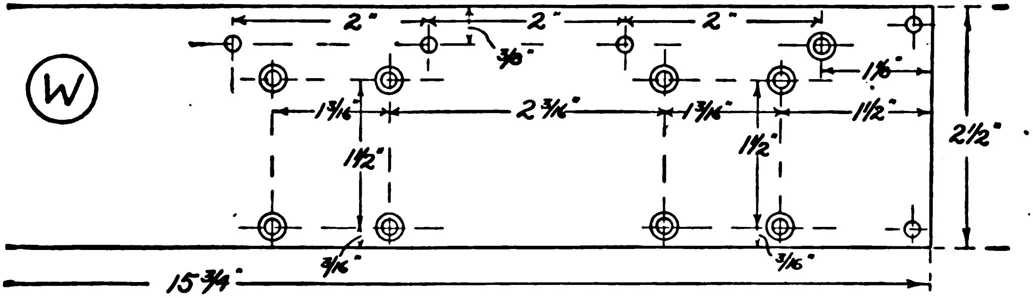
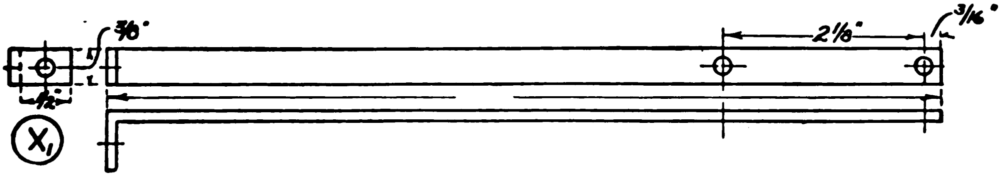
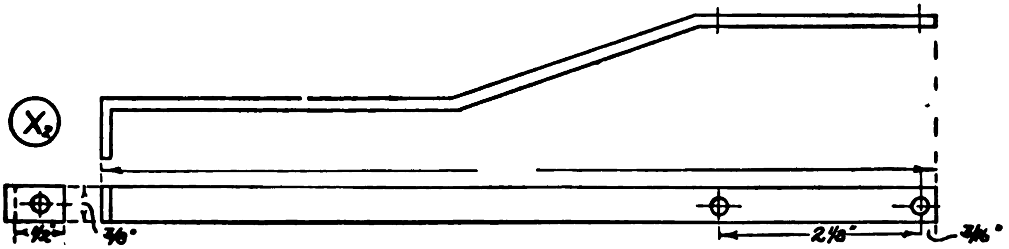


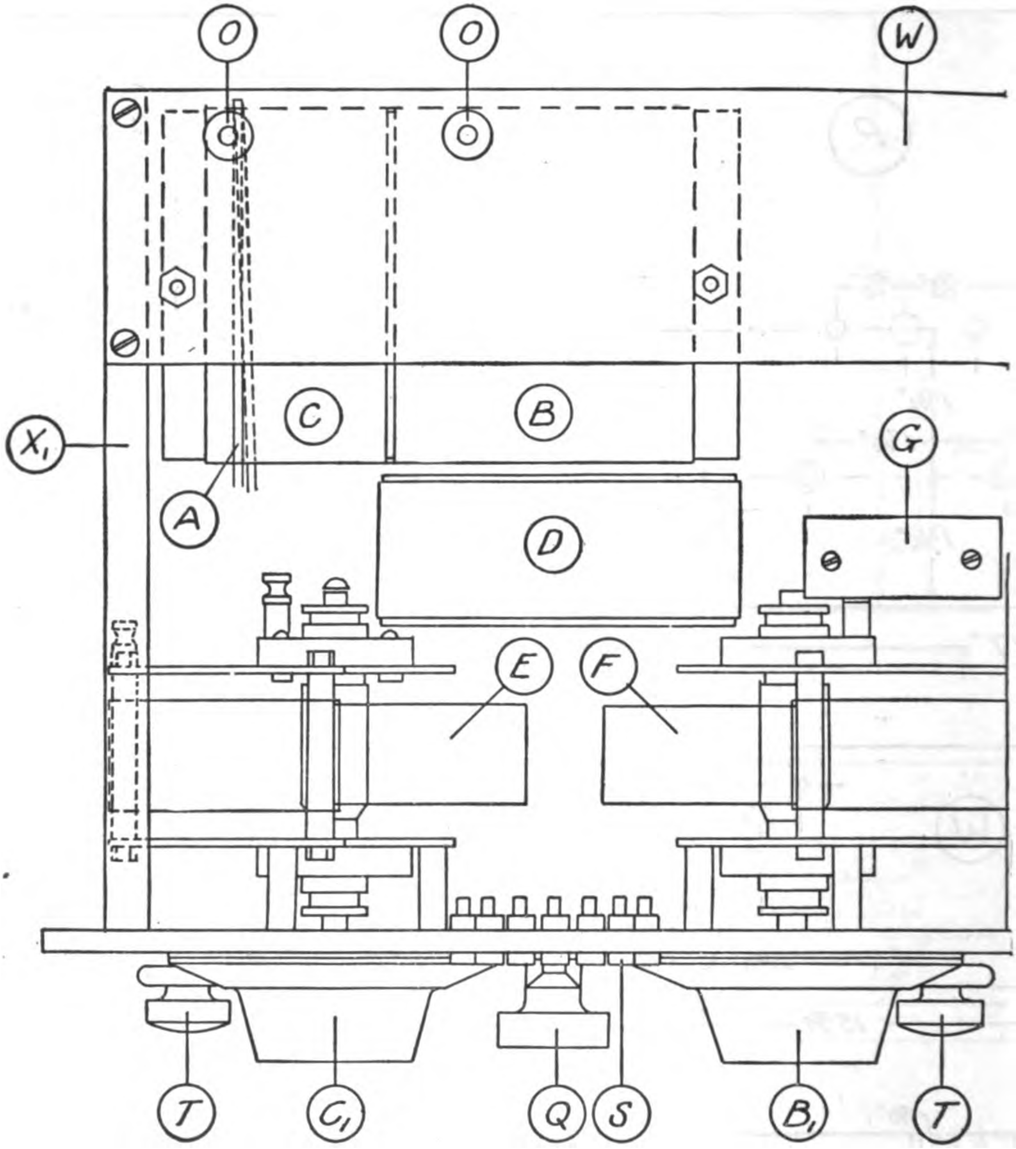
FIGURE 4
(at right)
Here are shown the exact dimensions of the shelf panel and of the brass and phosphor-bronze brackets that are used for supporting the various parts of the set.


P
2 1/16"
2 3/4"
1 1/8"
3/4"
5 3/16"
5/8"
5/8"
1/2"
1/2"
1/2"
1/2"
1 5/16"
1 3/4"
1 3/16"
1"
1 1/16"
7/8"
1 5/16"
1 7/8"
17"


W
2"
2"
2"
3/16"
1 1/16"
1 3/16"
2 3/16"
1 3/16"
1 1/2"
2 1/2"
1 1/2"
1 1/2"
3/16"
3/16"
15 3/4"


3/16"
2 1/8"
3/16"
1/2"
X1


X2
1/2"
3/16"
2 1/8"
3/16"

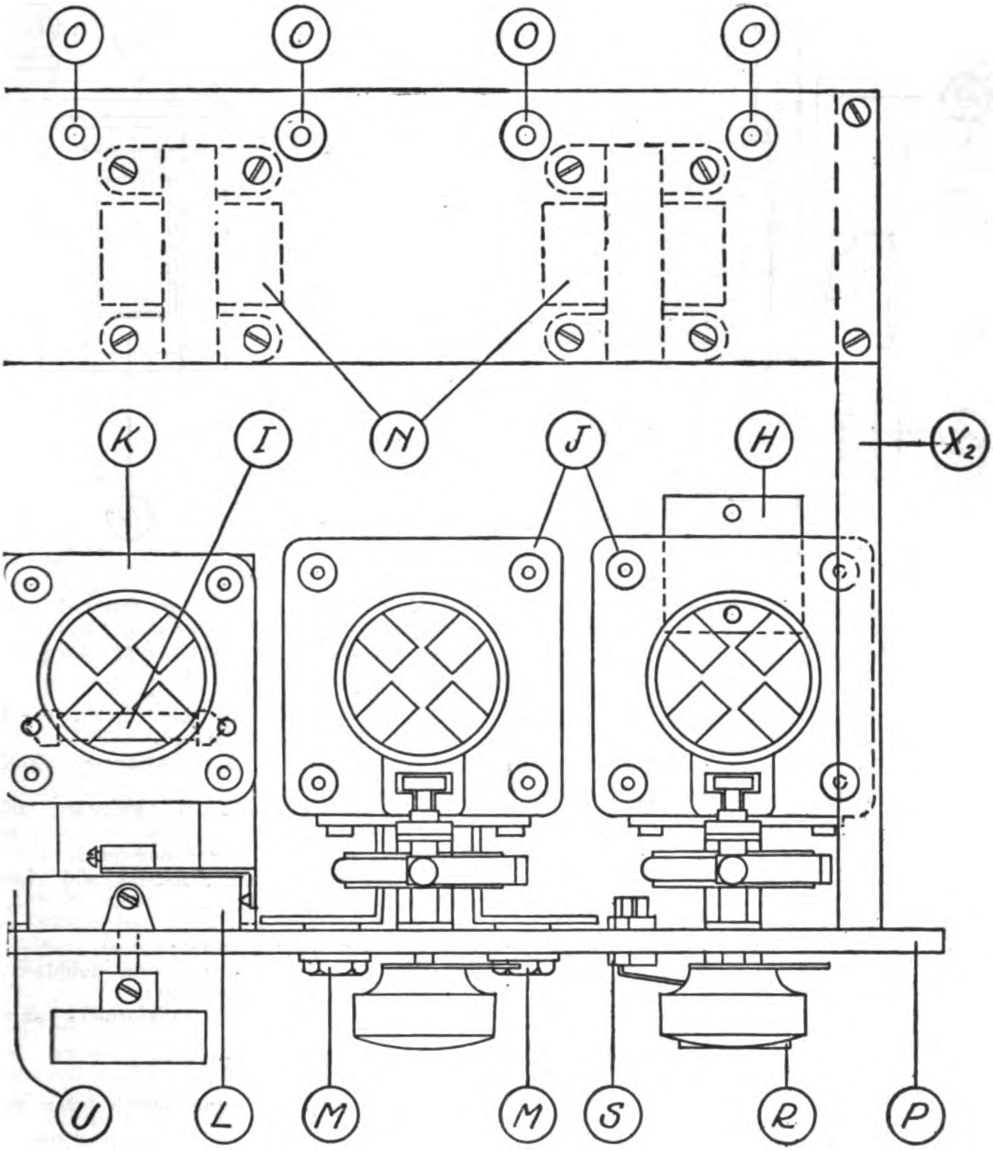


A WORKING DRAWING FOR ASSEMBLING THE SET

FIGURE 5: *A view of the set from above, showing the exact positions for the coils, condensers, transformers, tube sockets, switches, rheostats, and control dials. If the two panels used in the set are made as shown in Figures 3 and 4, the instruments will fit (as shown here) in a compact and efficient layout.*

no variometers, variocouplers, feedback coils, or tuned plate circuits are necessary. No variations of coupling are necessary, and the regeneration can be *set* and it will *stay put* over the entire wavelength range.

Another advantage of the system is that the constants of the antenna system make little or no difference on the other circuits; in other words, the set can be tuned on one antenna of totally different characteristics from another antenna and the two antennas switched with the signal still remaining tuned in. When receiving C. W. signals, the hands may be placed on the bare antenna wire without

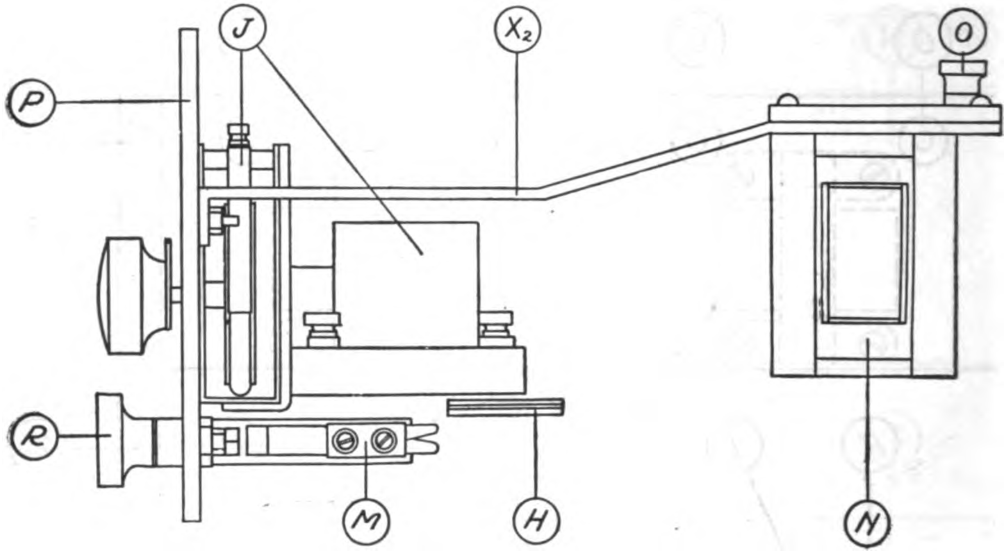


detuning the signal; in fact, the hands may be placed across the antenna and ground terminals. The antenna may be taken off or the ground lead taken away with signals still remaining tuned in but slightly weaker.

Fourth, to insure truthful reproduction we have added to the two-stage audio frequency amplifier a control for eliminating tube noises and for clearing up music and voice signals. This device makes music sound just as if it were being played in the room where it is received.

The set has, during the last few months, on all kinds and types of antennas, picked up about three quarters of all the broadcasting stations in the United States on a loudspeaker, and amateur stations in all the nine districts of this country and amateurs in other countries of this continent and in Europe.

The set as here described is not sensitive to body capacity and does not have to be externally shielded.



SIDE VIEW OF THE SET—FROM THE RIGHT

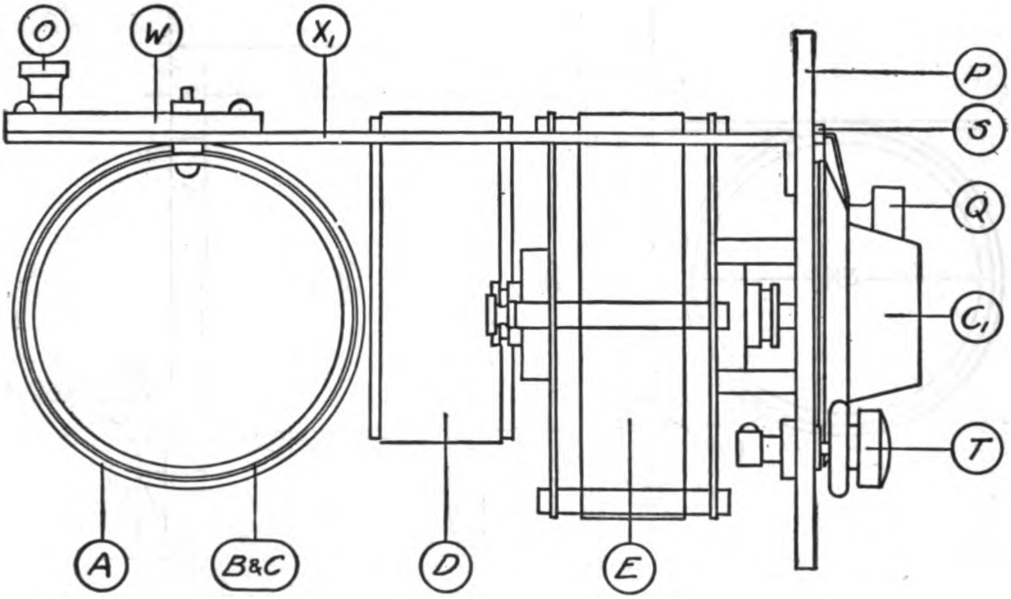
FIGURE 6: *This diagram shows how the rheostats, tube sockets and jacks are fastened to the main panel, and how the amplifying transformers are hung from the shelf panel in the rear. The condenser H is hung directly under the last socket and is supported by the connecting wires.*

The electrical circuit diagram is shown in Figure 1.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver may easily determine how to mount the instruments in the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below. The list of parts includes the exact instruments used in the set from which these specifications were made up; however, there are many other reliable makes of instruments which may be used in the set with excellent results. If instruments other than the ones listed are used it will necessitate only the use of different spacing of the holes drilled in the panel and shelf for mounting them.

A—primary winding, consisting of a single turn of tinned copper bus-wire, 1/16 inch square;
B—secondary winding, consisting of 65 turns of No. 18 S. C. C. copper wire;
C—reaction-stabilizer winding, consisting of 34 turns of No. 18 S.C.C. copper wire; (Coils A, B and C are wound on a composition tube, the dimensions of which are shown in Figure 8.)
D—antenna tuning-coil, consisting of 43 turns of No. 18 S.C.C. copper wire, double bank-wound, on composition tube; (See Figure 8.)
B1 and C1—Tait 3½-inch knobs and dials;
E and F—Se-Ar-De variable condensers, 17 plates, approx. .00035 mfd.;
G—Dubilier micadon fixed condenser, .00025 mfd.;
H—Dubilier micadon fixed condenser, .002 mfd.;
I—tubular grid leak, 1 or 2 megohms.;
J—Se-Ar-De combination sockets and rheostats;
K—De Forest socket;
L—Jenkins vernier rheostat;
M—Pacent or Federal jacks, one double-circuit and one single-circuit;
N—Jefferson amplifying transformers, small type;
O—Fada binding posts;
P—composition panel;
Q and R—Haydon-Fenton switch lever and knob;
S—switch points;
T—Haydon-Fenton vernier controls;
U—brackets for mounting the De Forest socket;
V—phosphor-bronze spring contacts for mounting the grid leak;
W—composition shelf panel;
X and X2—brass brackets for mounting shelf panel;
Y—detector tube, preferably a UV-201, or C-301 or a De Forest tube;
Z—amplifier tubes, preferably two C-301a's or two UV-201a's;
one cabinet, dimensions as shown in Figure 9;
connecting wire, 1/16-inch square tinned copper bus-wire;
screws and nuts to fit.



SIDE VIEW OF THE SET—FROM THE LEFT

Figure 7: *In this diagram is shown the method of attaching the tuning condensers to the main panel, and of attaching the coils A, B and C to the shelf panel. The antenna tuning coil D is suspended between the other coils and the condensers.*

How to Construct the Set

After procuring all the instruments for building the receiver, the amateur should set about preparing the panel P (shown in Figures 2, 3, 5, 6, and 7).

First of all, the panel should be cut to the correct size (5⅜ by 17 inches); then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 3.

The holes outlined here with a double circle should be countersunk so that the flathead machine screws used for fastening the instruments will be flush with the panel. All the rest of the holes in this panel are straight drill holes. Sizes for the diameter of these holes have not been given, but the builder will readily decide what size hole is necessary by measuring the size of the screws and shafts of instruments that have to go through the holes.

When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull, permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, the condensers, E and F, should be fastened to the panel in their respective places, as shown in Figures 2, 5, and 7, and the dials B1 and C1 should be affixed as shown. These dials are fitted with a chuck which centers and holds fast to the shafts of the condenser without the use of set screws. This insures even running of the dials when they are revolved and eliminates wobbling.

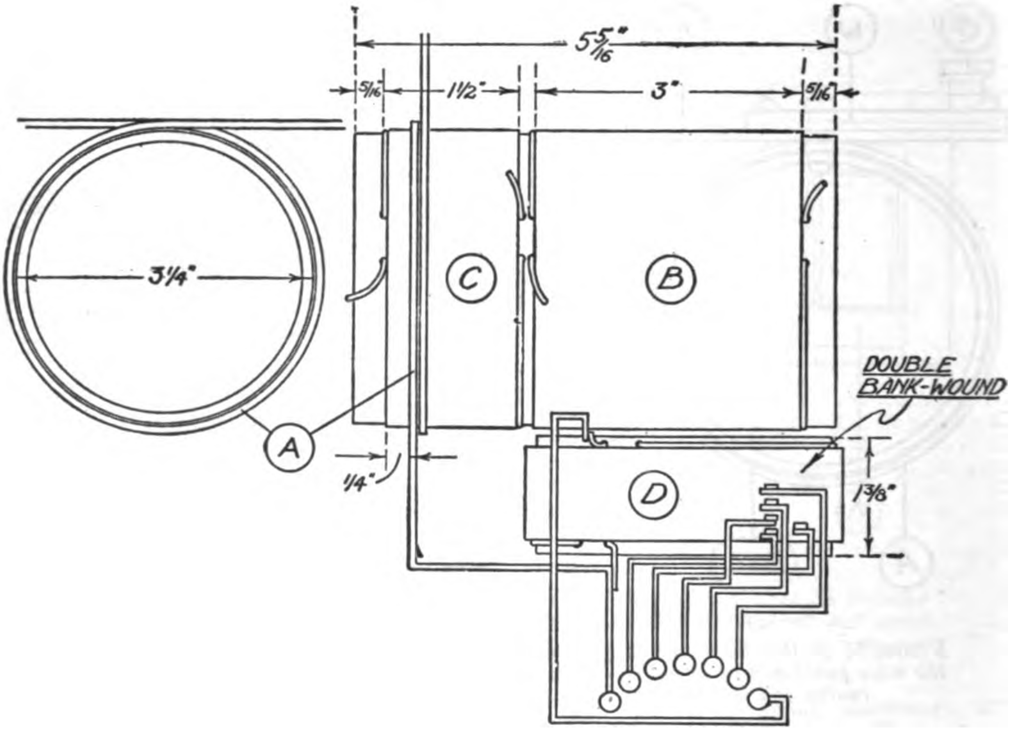
The two combination sockets and rheostats J, should be mounted on the panel (two screws to each instrument) as shown in Figures 5 and 6.

The detector vernier rheostat L should also be mounted in its proper place by means of two screws (see Figure 5). The detector socket K will require two brass brackets U, for attachment to the panel, and these should be of the dimensions given in Figure 4. The two grid leak phosphor-bronze springs V (shown in Figure 4) are mounted on these brackets, underneath the socket. Two holes will have to be drilled in the socket, one on each side (as shown in Figures 2 and 5) for fastening with brass nuts and bolts to the brackets U. The grid leak springs are held by the same bolts.

The three rheostat knobs should now be connected to the shafts of the rheostats protruding from the front of the panel.

Place the switch points S in the proper holes drilled for them and fasten with small nuts on the rear of the panel as shown in Figures 2, 3, and 5. Insert the two switch levers Q and R and make fast in the proper manner with the nuts furnished with the apparatus.

Mount the two jacks M, the double-circuit jack at the left and the single-circuit jack at the right, as shown in Figures 2, 5, and 6.



HOW TO MAKE THE COILS

FIGURE 8: *Here are shown the dimensions for the coils and the method for connecting the single turn of wire A to the coil D and to the taps S. The positions of these coils in relation to each other should be observed strictly.*

It will be noted that the two jacks should be mounted "back to back," as the space is limited. (There is really no benefit derived from using a jack in the first stage because the same results can be obtained by burning the two amplifier tubes at a low filament temperature and thus getting the same results as from one stage. This will save the tubes as they will last longer, burning dimly, than one that burns brightly.)

The last job on the main panel is to mount the two vernier controls T, for the condensers E and F (see Figures 5 and 7). These are necessary on account of the sharpness of tuning in this set.

Next, cut and drill the shelf panel W, as shown in Figure 4 and prepare the two mounting brackets X1 and X2, shown in the same diagram. These are fastened to the shelf panel and also to the main panel P, as shown in Figures 5, 6, and 7. The straight bracket is used at the left side of the set. The irregular shaped bracket X2 is used at the right side of the set, and the reason for using it is to allow space for all makes of tubes to fit into the last socket.

Now mount the two transformers N on the shelf W, using four screws to each transformer, as shown in Figures 2, 5, and 6.

The six binding posts O should be mounted in a straight line at the rear of the shelf and fastened underneath with nuts, in the regular manner.

In preparing the tuning elements great care should be exercised, for in the *exact* following of the instructions here given lies the success that can be had with the completed set.

First, cut the 3¼-inch tube to the right length, as shown in Figure 8. (If you have trouble in getting this size, use 3½-inch tubing; it will raise the wavelength only slightly.)

Start winding the coil C, finishing with 34 turns of No. 18 S.C.C. copper wire. Right next to this wind on the 65 turns of the same kind of wire for coil B. Then fasten the tube with the two coils wound on it to the shelf W with two screws and nuts (see Figure 5), and insert a washer between the shelf and the tube, as shown in Figure 7. This will leave a little space for the single turn A, which can be put on when the wiring is being done.

The antenna tuning coil, is a double-bank-wound coil on a tube the same diameter. The taps are taken off, one at the beginning of the coil, then one at the third turn, one at the 7th, 13th, 21st, 31st, and one at the end, the 43d turn.

In bank winding, the tube is shellaced with a light coat and while it is still wet, two turns are wound upon it.

Then the next turn is run up on top of the two turns that are already completed and a whole turn is put on.

When this turn is completed the wire is turned down on the tube again and another turn completed; the next turn is run up alongside the first top turn, then down, then up, and so on. In the set described the coil D was held in place by the stiff bus wiring, but it may be fastened to the shelf by a straight piece of brass and two screws and nuts (brass).

The two condensers G and H may be attached in the proper places when the wiring is being done, as they are held in place by the wiring.

How to Wire the Set

The design of this set is such that the grid circuit wiring of each of the three tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are arranged so that short connections may be used. As this is the case the set may be wired with bus-bar, with little loss in efficiency.

A tinned copper square wire is recommended. It should be about 1/16 inch square. All connections should first be shaped so that they will fit, and then soldered in place.

The binding posts along the back of the shelf W (design in Figure 5) are to be connected in the following manner:

First on left, antenna;
Second from left, ground;
First on right, amplifier "B," positive;
Second from right, detector "B," positive tap;
Third from right, "B," negative, and "A," positive;
Fourth from right, "A," negative.

It will be noticed in diagram (Figure 1) that the ground and the "A," negative, are connected together.

Start wiring the filament circuit, being sure to include the rheostats in the correct side of the filaments as shown in Figure 1. *This is important.*

Wire up the antenna circuit, including the placing of the single turn A, of the bus-wire, around the inductance in position shown in Figure 8 and connect to coil D and the taps S. One end of the loop A goes to the antenna post and the other goes to the first tap S and the beginning of coil D as shown. The switch lever Q is connected to the ground post.

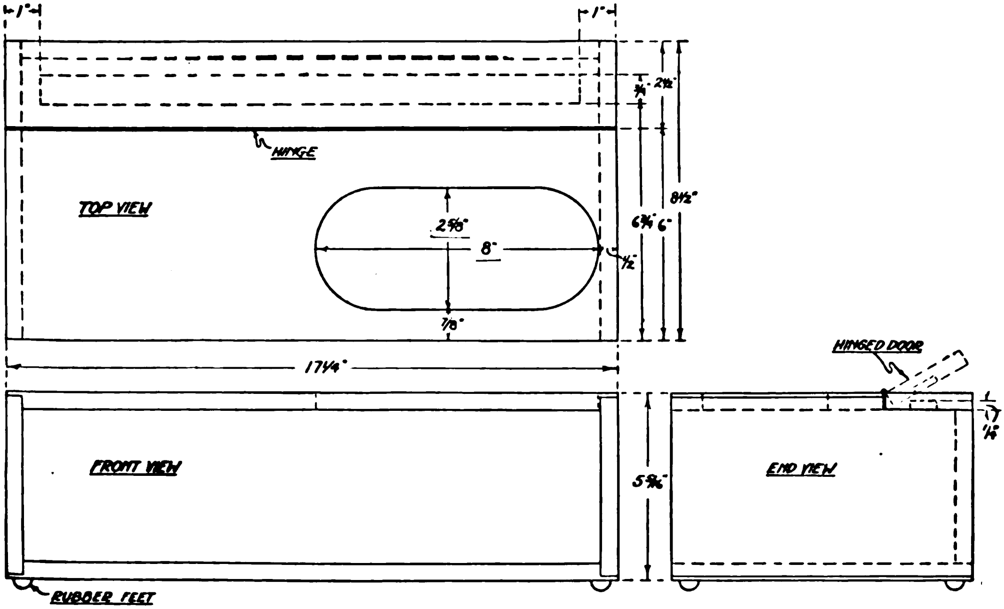
Now wire the two leads from coil C, to the terminals of the condenser E.

Then start with the secondary wiring (coil B, condenser F, condenser G, and the grid leak I) and connect exactly as shown in the diagram Figure 1.

Wire the plate circuit of the detector tube, including the jack, the primary of the first amplifying transformer and ending up at the detector "B," positive, binding post.

Next, finish up the first stage of amplification, and then continue with the second stage.

The last job to complete is to connect the condenser H to the switch lever R and the



HOW TO BUILD THE CABINET

FIGURE 9: *This working drawing of the cabinet, which contains all the necessary dimensions, may be turned over to a cabinet maker, who will be able to construct it of some hardwood—such as mahogany or oak. The hinge used is a section of piano hinge and may be finished in nickel.*

grid of the last tube, and also connect up the two end-taps S, as shown in Figure 1. This is the tone control of the amplifier and will give the operator three separate adjustments.

After you have finished the job, sit down with some friend and check over the wiring once or twice before using the set. This will save yourself a lot of trouble in case you have made a mistake.

Operating Data

When using the set, the following hints will be of practical value:

The set may be used with any antenna that is about 100 feet long—the longer the better. It also works well with a multi-strand antenna.

By lifting up the little hinged door at the top and back of the cabinet, the connections may be made in the following order, to the antenna, ground and batteries, commencing at the left (looking at it from the front):

First post, the antenna;

Second post, the ground;

Third post, the "A" negative;

Fourth post, the "A" positive and the "B" negative;

Fifth post, the "B" positive tap for the detector, 22½ volts;

Sixth post, the "B" positive for the amplifiers.

Close the lid.

All antenna tuning is done with the switch lever Q. All secondary tuning is done with the dial B1 and the vernier control T for that dial. Regeneration is controlled by the dial C1 and the vernier T for that dial.

Place the detector tube Y in the socket, and place the telephone plug in the first jack and turn up the filament rheostat all the way. Then turn it back so that the filament is left at three-quarters brilliancy.

Now take the plug out of the first jack and put it into the second. Insert the two amplifier tubes Z, and just touch the rheostats to the first wire on the rheostat. Do not turn them up any farther. This is the way they are supposed to operate; they should not be turned up higher.

Set the dial C1 at 100, with the condenser "all in," and tune with the dial B1, until you pick up a signal. Then revolve the switch lever Q until the best tap is found. Turn up the rheostat L until the tube starts to oscillate and then turn it down slightly below this point. All further adjustments should be made with the two dials B1 and C1. The lower the value at which C1 is set the more the set will oscillate so that the regeneration can be easily controlled by the combined action of the two dials B1 and C1. You will soon get the knack.

Amateur C. W. signals should be tuned with the dial C1 somewhere between 0 and 80. All phone stations will be found to come in better with this dial somewhere between 60 and 100.

On dial B1, the amateurs tune between 0 and 15, and the broadcasting stations between 20 and 65. The antenna taps at the left will be best for amateur work, and the middle taps or the right taps for the broadcasting; it all depends on the size of the antenna, but you will soon learn the best taps to use with a little practice.

S. R. Winters

A NEW RADIO-OPERATED CODING AND DE-CODING DEVICE

This new apparatus, known as the Hebern electric code, is used like an ordinary typewriter; words are spelled out on it in any language and the machine itself does the coding. This is accomplished by means of rotating discs which are set on a key letter both at the transmitting and at the receiving end. These discs "scramble up" the message into five-letter groups and the different letters in the original message are replaced by other letters in combinations which number up to 40,303,146,321,064,147,046,400,000 distinct and different combinations. It has been estimated that it would take the whole staff of the Government's code experts at least 100 years to decode one message or even one word of one message sent out by this instrument, without the aid of the receiving machines.

HOW TO BUILD YOUR OWN
WAVEMETER

The Penalty for Exceeding Your Wavelength—

For the amateur who transmits on a wavelength exceeding the prescribed 200 meters, a fine of $25.00 may be imposed for each offense. If he persists in his transgression, his license may be suspended or revoked altogether.

WATCH YOUR WAVELENGTH!

By W. K. THOMAS

From a photograph made for POPULAR RADIO

EVERY amateur who operates a transmitting apparatus ought to have a wavemeter—for his own protection. Yet few amateurs own one.

No transmitting set can be adjusted properly for wavelength without the aid of an accurate wavemeter. In the proper adjustment of a spark transmitter a wavemeter is indispensable, as a resonant condition between the closed and open circuits is far more essential for maximum efficiency than "antenna current."

In obtaining resonance in a tube transmitter the amateur is usually guided by the use of various voltmeters, ammeters and milliammeters. But reliance should not be placed upon guesswork in determining the length of the emitted wave. Our Government through the Department of Commerce has complete jurisdiction over radio communication and has designated the operating wavelengths of various classes of stations, and these wavelengths must be adhered to strictly in transmitting. The amateur who uses a wavelength greater than that to which he is entitled is in danger of forfeiting his license.

The amateur who wants to build his own wavemeter—and the task is not difficult—will find the following instructions of practical value. The apparatus here described is really efficient; for amateur purposes, indeed, it may well take its place alongside the justly famous Kolster decremeter.

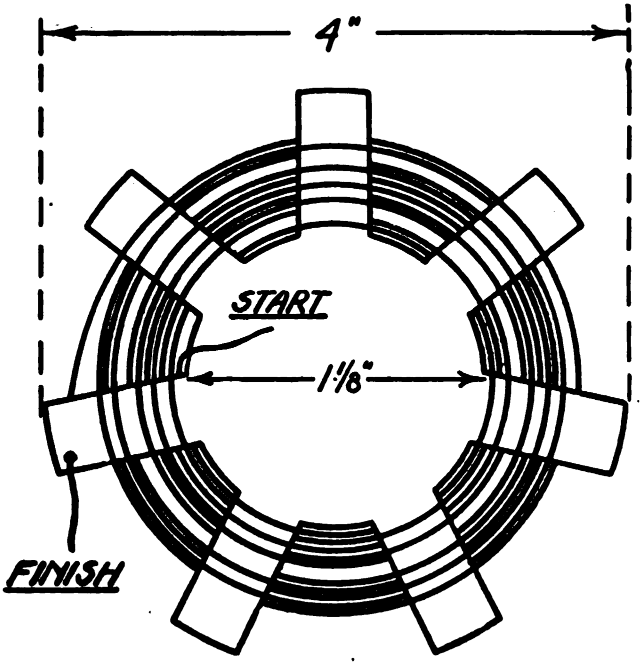


FIGURE 1

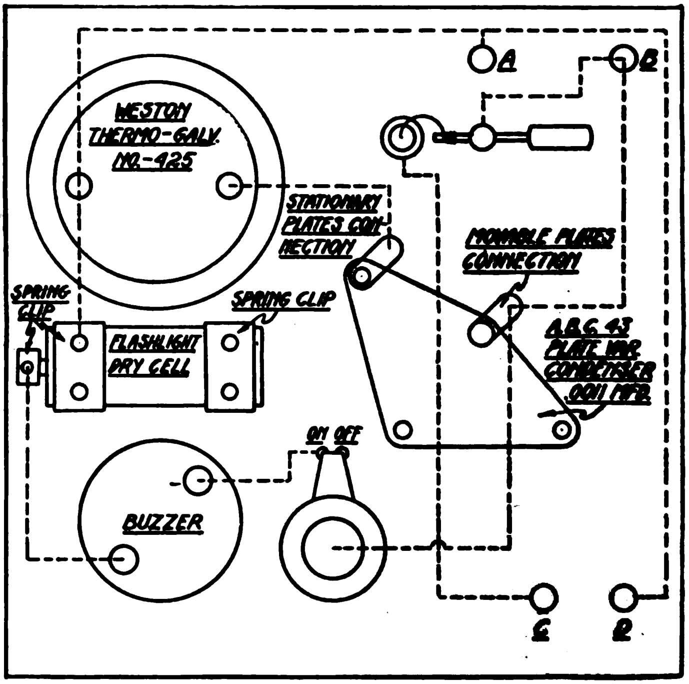
How to make the coils. Coil 1 has 20 turns on it, and coil 2 has 42 turns. This is the only difference.

The specifications call for the following material:

- 1 pc. bakelite 3/16 by 8½ by 8½ inches
- 1 Weston thermo-galvanometer No. 425
- 1 1½ volt flashlight cell
- 1 Century buzzer
- 1 rotary switch lever
- 2 contact points
- 1 variable condenser .001 mfd. with dial
- 2 binding posts
- 1 suitable oak or mahogany case

The schematic drawing (Figure 2) shows the electrical connections; the dotted lines represent wires which should be of No. 14 solid-copper wire covered with cambric tubing.

In Figure 6 is shown a circuit diagram, and in Figure 3 a drilling plan of the panel. Across the binding



A
B
WESTON THERMO-GALV. NO-425
STATIONARY PLATES CONNECTION
MOVABLE PLATES CONNECTION
A.B.C. 43 PLATE VAR. CONDENSER .001 MFD.
SPRING CLIP
SPRING CLIP
FLASHLIGHT DRY CELL
ON OFF
BUZZER
C
D

FIGURE 2

Figure 2 shows a schematic drawing of the instrument layout with the circuit connections indicated by dotted lines.

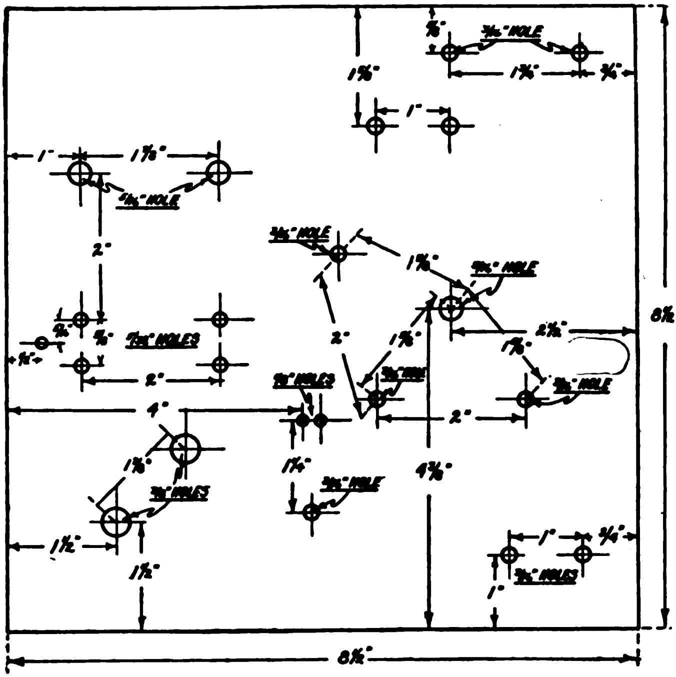


FIGURE 3

Where to drill the holes in the panel. Follow this diagram and know exactly what size the holes should be and exactly where they should be drilled.

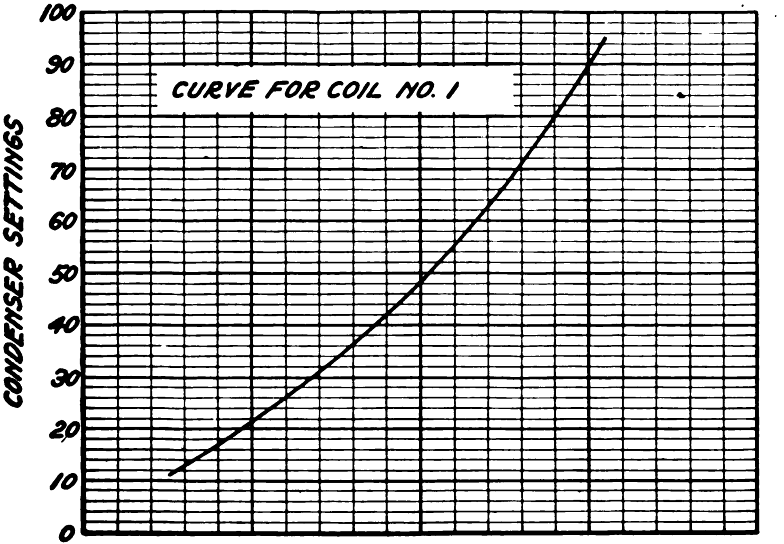


FIGURE 4

The wavelength chart for coil number 1. Run along the horizontal line, which corresponds to the number on the dial of the condenser in the wavemeter for a given setting, until you strike the curve; then run down the vertical line to the bottom of the chart to find the wavelength. Thus for a setting of 21 on the condenser we find a wavelength of 200 meters, on which amateurs transmit.

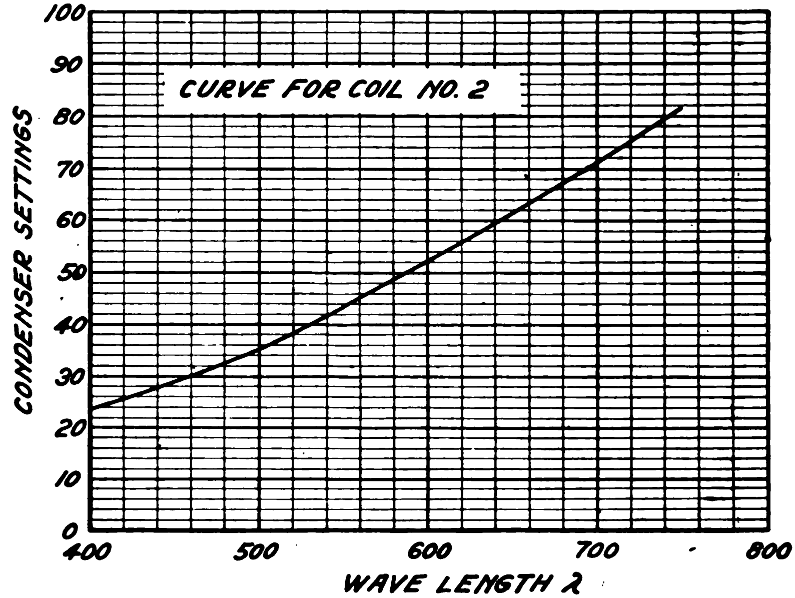


FIGURE 5

The wavelength chart for coil 2. This chart is used in the same manner as the chart shown in Figure 4. It will be noticed that coil 1 has a wavelength range of 150 to 400 meters and that coil 2 has a range of 400 to 740 meters.

posts A and B (Figures 2 and 6) are shunted the windings of the wavemeter coil which complete the circuit through either the meter or buzzer.

To calibrate a receiving set, place the wavemeter near the antenna lead-in wire, insert the desired coil across the binding posts A and B and place the rotary switch in the "on" position, closing the battery circuit through the buzzer and coil. Set the dial of the receiving set at zero and vary the position of the condenser dial on the wavemeter until the maximum sound is received in the head set that is connected to the receiving set.

Continue this process, taking readings of the wavemeter dial when the receiving dial is set at zero, 5, 10, 15, 20 and on.

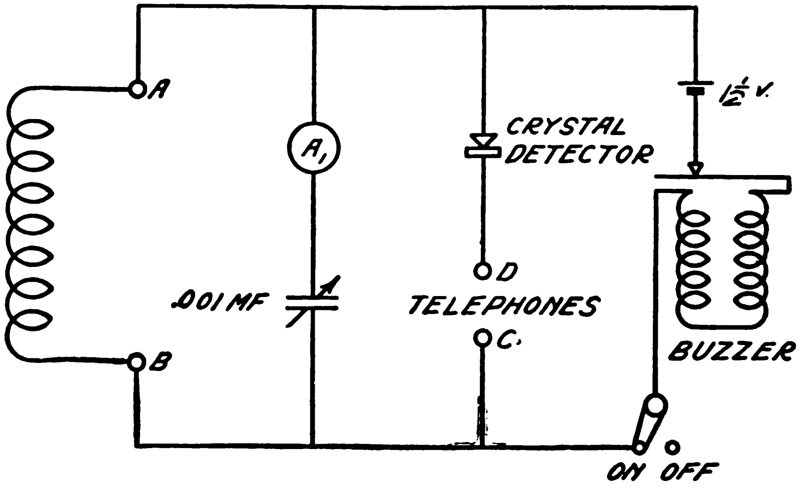
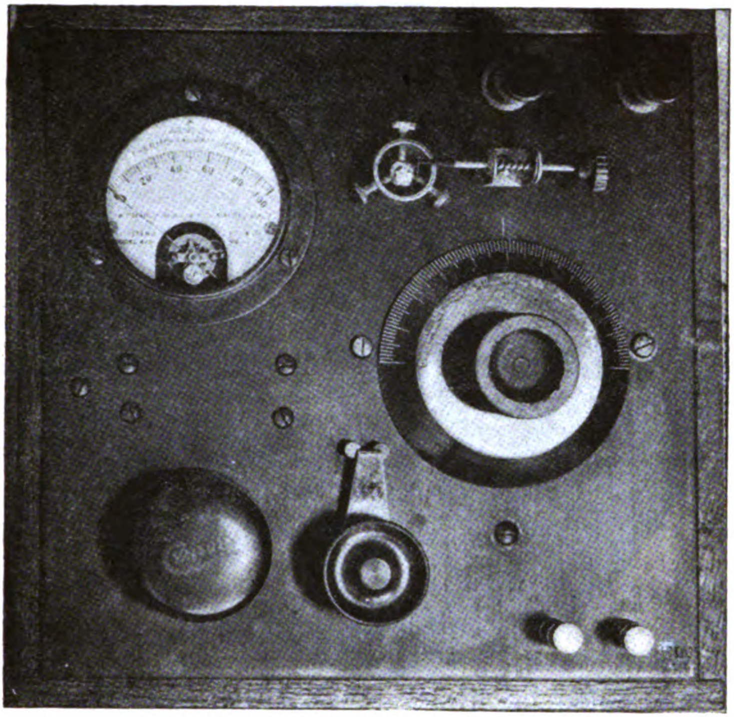


FIGURE 6

This circuit diagram shows the electrical hookup for the apparatus. Either coil 1 or coil 2 may be used across the binding posts in accordance with the wavelength range to be covered.



A PANEL VIEW OF THE COMPLETED WAVEMETER

With this apparatus the amateur may check up on two important points—the wavelength of the signals that he is transmitting and the wavelength of the signals that he is receiving. No radio installation is complete without this important measuring instrument.

Then by reference to the curve (shown in Figures 4 and 5) you can ascertain the exact wavelength of each of the various settings of the dial on the receiving set.

Once you have obtained the values at different points, you may plot a new curve for your particular receiver; thereafter you need merely to refer to this curve to learn at a glance the exact wavelength of an incoming signal.

This meter, it will be noticed, is also equipped with two extra binding posts to accommodate a pair of telephones to be used in conjunction with the crystal detector as shown in the circuit diagram in figure 6 and in the photograph at the top of this page.

To tune a transmitting set, the only change necessary on the wavemeter is to move the rotary switch to the "off" position; when the transmitter is in operation, bring the wavemeter near the apparatus and move the wavemeter dial until the maximum deflection of the thermo-galvanometer is noted. By reference to the curve you can immediately ascertain the exact wavelength of your transmitter.

Care should be exercised not to place the wavemeter too near the transmitter, as the thermo-galvanometer shown is very sensitive; the full scale deflection is equivalent to only 115 milliamperes. A thermo-couple milliammeter of 0-100 scale will also be suitable for this purpose.

For construction of the coils across A and B, see Figure 1. If every detail is followed closely in making the coils, the curves shown in Figures 4 and 5 are accurate within a small percentage.

The instrument described will be a guarantee that you do not exceed the wavelength allotted to you.

Shaw Photo, Boston

WILL THERE BE BUYING AND SELLING IN THE SKY?

Sooner or later the question must be settled as to whether or not vendors of merchandise, insurance and real estate will be admitted to the realms of radio for exploiting their wares. Mr. Lee, the famous author and advertising expert, here brings up some pertinent observations on this timely topic.

Marketing Mattresses in the Ether

Popular Radio does not believe that advertising matter should be intruded upon general broadcast programs, any more than it should be intruded upon motion-picture programs or the text columns of newspapers and magazines. Possibly a special waveband will some day be assigned exclusively to advertising; in which case the venture will succeed or fail in proportion as the paid publicity agents instruct or amuse us—as this article points out.

By GERALD STANLEY LEE

ADVERTISING men themselves, acting in combination with Mr. Hoover, have decided, I believe, that heaven is no place for them. They have decided that they should not be tolerated in the sky; they cannot even bear the thought of tolerating one another there!

This reveals a shrinking and a modesty on the part of advertising men that the American people have not previously been led to expect, and most of us cannot help wondering a little just now how long this shrinking of theirs is really going to be kept up.

When I first began to think of it I felt that this modesty was at least a good advertisement for advertising, that it was a good thing so long as it lasted and that it should be kept up. But on further thought I do not believe that the present feeling on the part of ad men will be kept up forever or that there is any permanent or unremovable reason why it should.

The reason given thus far for fencing off the big "vacant lot of space" above us and saying that no advertising men are to be allowed in it—the reason for saying that of course toothbrushes, mattresses, bathtubs, chewing gums and catsups and the other things must all keep out and that the air up over America must be reserved merely for breathing, soaring and other more unworldly and more spiritual interests and entertainments—is based on the idea that toothbrushes, mattresses, bathtubs, chewing gums and catsups will not behave themselves in the sky as they should.

Looking at the facts as to what advertising men would probably do with the sky if they were allowed to wander around in it nights, most people would have to admit what would happen. The air all about us from the rim of the earth up to the bottom floor of heaven would be one vast pandemonium of shouting and grabbing at people's pocketbooks.

This idea of what radio advertising would be like if let in on us suddenly is not one I quarrel with, so long as I keep looking at the facts about advertising as they are.

But when I look at the facts about advertising not as they are but as they might be, and as I believe advertising men are going to make them, I feel differently.

All that advertising men need to be is sensationally good, incomparably more

Western Electric

PRESS AGENTS MAY HIRE THIS STATION FOR 10 MINUTES FOR $100

The justly famous WEAF station in New York is for rent—at a specified price. It is maintained by the American Telephone and Telegraph Company as an experiment to determine whether or not there is a market for a toll-station of this kind.

entertaining than the present education and the present entertainment that flourishes around up in the air; and the time will soon be at hand when people will feel that advertising men, at least some advertising men in this country, can honestly earn their right to the air—their right to butt in as a matter of course on jazz and on "The Man in the Moon."

Competition works in the air as well as anywhere else. An advertisement is not intrinsically an affront, not if it really draws; and when the Dear Public, as I have seen it do, sucks on an ad like a lollypop, even Mr. Hoover is not going to have the heart to stop it.

The time is coming when, if the best ad men do their part, the sign up across the heavens that has been tacked up now,

NO AD MEN ALLOWED ON THESE PREMISES

will have Mr. Hoover stealing out in the dark some night and reaching up between the stars to take it down.

It will be taken down at least for certain ad men. The principle will be established that if men are exceptions they will be treated as exceptions.

The minute the real Bud Fishers, Charlie Chaplins and Babe Ruths of the air once appear in the interstices of space and begin clearing their throats there, if they are more amusing, more instructive and enjoyable about a soap than other people are about the League of Nations, everybody will buzz to them to go ahead. They will be given the very floor of heaven.

People are not going to stop listening to a man who makes them want to listen, merely because he is paid a high price for being the kind of man who can make people want to listen. Making them want to listen is the thing. People will like it and they will like his being paid for it.

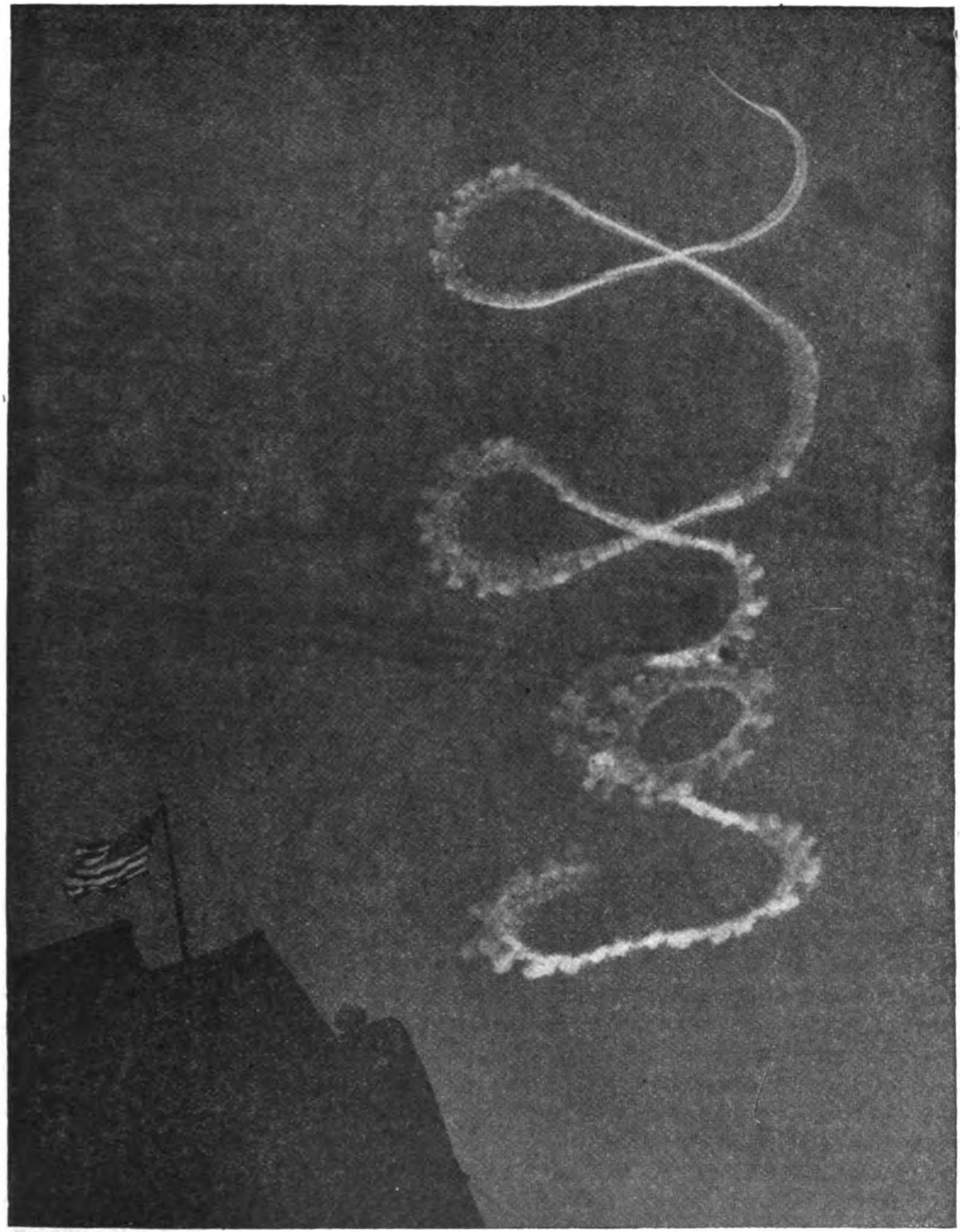
It has seemed to me for some time, as some of my readers know, that advertising—the art of touching men's imaginations so that they know something about themselves that they never knew before or that they never even wanted to know before—is one of the great professions. As the profession is interpreted by men who might yet be got to practice it, it calls for a kind of gift and a degree of gift which makes a man who has it and who determines men's lives with it fit to be listened to anywhere and listened to on almost any subject.

The invention of the radio telephone and the inauguration of broadcasting, instead of being made the occasion of a national snub to advertising men which they feel they must meekly bear, should be and I believe is going to be recognized and taken advantage of by many as the profession's great opportunity.

If the advertising men of America had wanted to pick out or arrange a picturesque and dramatic crisis for their profession in this country, if they had wanted to arrange a kind of gunpowder plot of publicity—a blaze of limelight in which to prove that advertising must be recognized as one of the greatest and the most honorable of the professions—they could not have done a better thing than to get themselves sensationally shut out of heaven, as they now are, and then with everybody looking on and everybody listening, begin doing things and saying things that will make people want them invited back again.

Perhaps the best way to make a start would be for The National Association of Advertising men to plan out and get under way what might be called a national tournament of advertising, a series of prize tests, and proceed to present to the American people in the quickest possible time advertisements that the American people would want broadcast.

A great profession is confronted with a loud, plain challenge from the people. It has a chance to look itself over and sort itself out. People are already interested in our national advertising men. They would be especially interested in seeing which are the ones that can get



© Jack Sussman

THE "WRITING" ON THE FLOOR OF HEAVEN

The use of radio for controlling the airplanes that have indulged in the spectacular sky-writing of advertising slogans in London and New York has become more than mere theory; recent experiments in England indicate that planes guided by living pilots may soon be replaced by planes controlled by radio from ground stations. The "writing" is done by means of smoke from special devices that eject 250,000 cubic feet a second; the letters are about a mile high. The above photograph was made while Captain Cyril Turner was sky-writing the telephone number "Call Van 7100," about 10,000 feet above New York.

invited into the sky and which will be kept out.

Instead of saying sweetly and modestly, with a whole nation looking on, that they agree that the men who belong to the advertising profession cannot compete with other human interests and activities in earning the right to be allowed in our new annex on the world, our best advertising men, I believe, are going to accept the challenge.

The main principle which should be employed in determining the question of advertising in the air is the great democratic and spiritual principle that people should never be treated as if they were alike.

The idea that all men are created free and equal is not an idea anybody really believes as it is usually interpreted. It is a mere Fourth of July incantation. Nobody who accomplishes anything or lets anything be accomplished through him ever acts as if it were so. Every man in America gets up every morning and goes to bed every night proposing to be treated as if he were somebody in particular. Advertising men, like the rest of us, expect to suffer the penalties of being individuals.

The very essence of democracy, the juice and gusto of the whole idea, lies in the fact that we in this country do not believe that society is put up in big, soggy, undigested lumps of people. We dissolve these lumps into real human beings and treat them as they really are. The idea that all the men in any group or in any profession should be lumped together and treated in the same way by the government and by the laws of the people may be convenient, but it is superficial and lazy and in the long run expensive and drains the creative resources and finer powers of a nation like ours.

The only thorough, honest, economic, ethical manner of dealing with crowds or masses of men is never to give them privileges as if they were all alike. They are not all alike and they all feel and know that they are not alike; in their hearts they don't want to be alike and they hate to be treated as if they were. It is an anæmic, overworked and tired thing for our government to deal with advertising men as a group. If the government does not want to devote its brains to picking out some advertising men who are good enough for broadcasting, the National Advertising Association can establish publicity tournaments or adopt other means to determine exceptional men and to have them dealt with as a great nation wants them to be.

One of the biggest shoves forward that our civilization, our buying and selling civilization, is going to have, will come when our inventors perfect talking back in the sky. The first minute people can clap and boo in the sky, can make a man blush or stutter when he gets up to talk in it, millions of us who have been waiting to get even with some ad men in this country—ad men who have been hitching at our elbows and hollering in our ears half our lives—millions of us are going to have a heavenly time.

Incidentally, the advertising profession is going to get its reckonings and take its soundings. It is going to front itself and confront the people with facts that nobody can explain away. We shall spell out the names in the sky of the men whose advertisements grip. Publicity in America at last, instead of being a kind of splendid national guesswork, will proceed to establish itself as both a science and an art.

In the meantime, until our inventors perfect some suitable inexpensive device for sky back-talk or at least for taking a rising vote in the air, the best arrangement for determining which of our ad men should be let in to the sky would seem to be a vote by mail. We shall have to fall back on some such preliminary test placed before the public, as the National Advertising Association or some like organization may, for the glory of the profession, devise and set up.

Help *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

The Senate Fails 3,000,000 Radio Fans

THE failure of the Senate to pass the White radio bill was a grave disappointment to the great army of radio fans as well as to the radio industry. To meet the emergency which has thus been created, the Secretary of Commerce, Herbert Hoover, re-convened the Radio Telephony Conference Committee of last year, with the purpose of working out a practical plan of action to tide over the period until Congress assembles again. What this Committee did—(it is in session as this number of Popular Radio goes to press)—will be told in the June issue of this magazine by Mr. Paul Godley.

* * *

A New and Improved Vacuum Tube

AMATEURS who have advanced beyond the crystal-detector stage of development will be interested to know of the recent arrival of a brother of the UV-201 tube, popularly known as the "radiotron." Here is a brief description of it:

> A new and improved radiotron, type UV-201-A, superior in many respects to the UV-201 tube and designed to supersede the latter, has recently been announced. While in outward appearance the new tube resembles its predecessor (with the exception of a slight discoloring of the bulb) the new tube incorporates several distinctive features. For instance, it contains a new and improved filament that requires only one-quarter of an ampere (.25) at five volts across the terminals of the filament; with this current the filament emission averages about five times that of the UV-201 tube. The filament, however, when burning at normal brilliancy, has a temperature materially less than that of the UV-201 tube.
>
> The tube has an exceedingly high vacuum, is quiet in operation and produces no inherent tube noises. The high vacuum assures uniform characteristics. It is particularly adapted to radio frequency amplification.
>
> In its operation as a detector, radio frequency or audio frequency amplifier, the results obtained are exceptionally independent of filament adjustment. Critical adjustments of grid leak or grid condenser are not required.
>
> The new tube may be used in any equipment which at present uses the ordinary tube and will give improved results. No adaptor is necessary when the standard four-prong socket is used.
>
> If the filament is supplied by a 6-volt battery, the resistance of the filament rheostat should be at least 4 ohms, preferably 6 ohms.

* * *

Theatrical "Try-Outs" by Wholesale

HERE is a novel application of radio to the work of the singers and instrumentalists of the stage:

> The musician and actor sell their goods largely by sample. Before the theatre manager engages singers or instrumentalists, he wants to see or hear them. For which reason a great deal of the performer's time between engagements is spent in appearing before managers for private tests. This is particularly true in the new field of musical opportunity opened up in moving picture theatres, for where there are only a few

cities in the United States far enough advanced musically to support grand opera, even for a short season each winter, even small towns now have their picture palaces and good operatic music is heard in them fifty-two weeks a year.

In Baltimore recently, a couple of young singers who have been successful in putting on "twenty-minute operas" in moving picture theatres, made a successful trial of radio as their booking agent. Justin Lawrie, tenor, and Fernando Guarneri, baritone, make their own condensed arrangements of famous operas. Moving picture opera is pretty strenuous work, involving four or five performances a day, including Sundays and holidays, and often the doubling up in more than one part of the program. Taking one's samples around in between times and singing for managers with a view to booking future time, is just so much more work.

Lawrie and Guarneri find that it can be done better by radio. Scheduled to "appear" recently on a Baltimore broadcasting program, they wrote moving picture musical directors and theatre managers within a radius of several hundred miles around Baltimore, enclosed programs from the theatre where they were then giving twenty-minute operas, and asked that their radio performance be listened to as a sample of their work. Several engagements were secured in this way, and they expect to use radio regularly in future bookings. For the singer, instrumentalist, quartet, chorus and orchestra, radio seems to be an improvement in booking because it enables the performer to show his samples to more than one prospective purchaser at the same time. It is estimated that there are now at least three thousand moving picture theatres throughout the country in which such artists seek and find engagements. If they use radio to secure booking in paid engagements, it may help to solve the problem, "Who is to pay the radio performer?"

James H. Collins

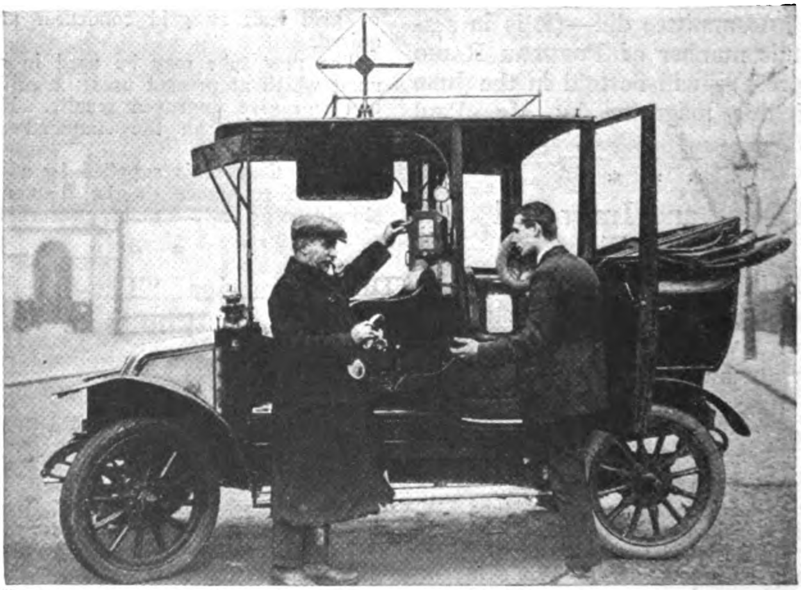
* * *

A Testing Battery for 11 Cents

If you own—or can borrow—a silver dime, and can find a drop of ordinary vinegar about the kitchen, you can create a miniature electric battery that is quite good enough for testing your headphones. This tells how to do it:

Take a dime and a one-cent piece and place them 1/16 of an inch apart. Then place a drop of common vinegar between the coins, and take care that the vinegar touches *both* coins. Nitric or sulphuric acid can also be used to a good advantage. Lastly, take the phone terminals and move them on the coins, for a contact must be made on both terminals. If you hear a faint scratching sound in the receivers you will know that your phones are working.

Walter A. Wachholtz



Keystone

RADIO ENTERTAINMENT—WHILE THE METER CLICKS

An ingenious London taxi-driver not only lures his trade by means of a receiving set installed in his car, but often collects additional fares while his patrons remain seated until the conclusion of an interesting program.

South Sea Love Songs in New England

TO listen in upon the actual folk-music of the world, played and sung by native musicians in their native lands, is one of the startling possibilities suggested by the rapid development of radio apparatus. Indeed, this possibility is already being realized, as Mr. Dunlap points out:

Radio followers who have had the pleasure of listening in to the melodies of New England from station WBZ in Springfield, Mass., Southern medleys from WSB in Atlanta, Ga., and Western songs from WOC in Davenport, Iowa, may increase their concert range by tuning in to the 400-meter wavelength of PWX in Havana, Cuba, which is now broadcasting in the evening, Cuban songs and tropical dance music. Experimental tests have been heard as far north as New Jersey; as the grade of radio reception is improving, it is expected that the radio waves of Cuba will be heard throughout the entire United States.

The installation of a broadcasting station on the island of Cuba indicates that the music of radio is gradually going to travel from continent to continent, first by advancing from island to island, as did the ships of Columbus. Radiophone broadcasting of concerts and other forms of entertainment is still in its elementary stage. Just as the baby learns to walk by stepping from one chair to another, so the music of radio will advance around the world from island to island before gaining sufficient strength to leap from continent to continent.

Many broadcasting stations have a power of 500 watts. Engineers predict that powerful water-cooled vacuum tubes now being developed will be capable of hurling 100,000 watts into space. Already the 500 watts of station WOR at Newark have carried the human voice across 3,000 miles of ocean to London, where listeners-in caught the voice and reported it by cable.

The performance of radio stations in transoceanic code reception at the present time casts a light on the future possibilities of radio telephony. An operator in the United States listening to Nauen, Germany, can, by slightly turning a dial, tune out the German messages and hear Bordeaux, France, or Honolulu. Radiophone listeners will soon find that by a simple tuning adjustment, they will be able to skip around the earth in the twinkle of an eye to enjoy the melodies of each country, rendered by the natives themselves.

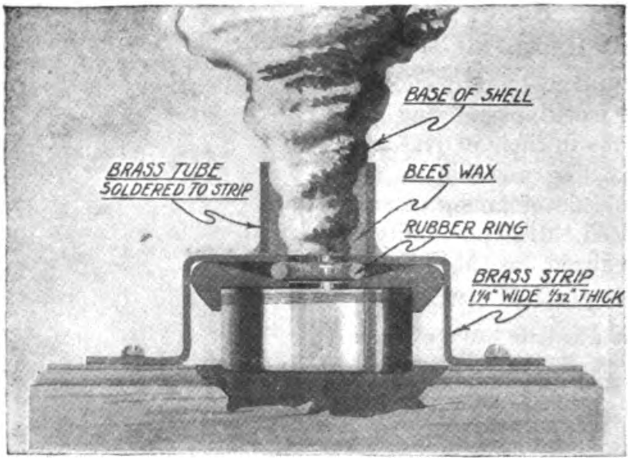
The radio concerts in the future will not be confined to the United States but every country in the world will represent the stage. Russian artists will be able to sing or play in Moscow and have their music heard just as clearly in New York as in the radio studio in Russia. One will be able to listen to the strains of American music played in Washington by a United States Navy band, or tune to the wavelength assigned to the British Isles and pick up the English folk songs broadcast from London, or French airs played in Paris. In a like manner will the songs of Spain and sunny Italy, the melodies of Norway, Hawaii and Japan be ever present on different wavelengths in the ether lanes.

Orrin E. Dunlap, Jr.

© Keystone View Co.

A LITTLE "LIGHT" ENTERTAINMENT

By merely throwing her antenna wire over a metal street lamp and attaching the ground wire to a man-hole cover, this young London radio fan is demonstrating how obsolete has become the phrase "deaf as a post." This particular lamp-post is serving as an aerial for receiving programs from the Eiffel Tower in Paris.


BASE OF SHELL
BRASS TUBE SOLDERED TO STRIP
BEES WAX
RUBBER RING
BRASS STRIP 1¼" WIDE 1/32" THICK

HOW THE LOUDSPEAKER MADE FROM A SEA-SHELL IS ATTACHED TO THE EAR-PIECE

The telephone is set into the shallow hole in the wooden base, and the small rubber gasket is laid in position. The sea-shell, which has been previously secured to the brass tube and strip as described, is then placed in position and secured to the base by means of two wood-screws.

A Skeleton as a Loudspeaker

FROM England comes a practical idea for using a sea-shell as a part of the amateur's home-made set. Not only does this boney object of nature give excellent results but it combines low cost with real beauty:

The chief part of a loudspeaker is the telephone—for, whatever its name might imply, the ordinary loudspeaker is only a single receiver ear-piece with a horn of some sort mounted on it. It requires at least two tubes to obtain a reasonable volume of sound unless the amateur enjoys the questionable good fortune of being in close proximity to a transmitting station. A single high-resistance receiver would be suitable. The receiver shown in the photograph is a 3,000-ohm telephone.

The base is made of mahogany and a shallow hole turned in the middle to keep the body of the receiver in place. The horn, as will be seen from the photograph, is a large sea-shell. A piece of 1/32-inch brass strip, 1¼ inches wide, is bent to the shape given in the sketch. It just clears the ear-piece, and a soft rubber ring is clamped round the centre hole. A piece of 1¼-inch outside diameter brass tubing is soldered on top of the strip.

The horn was cemented in place with beeswax. It was propped up in the right position and the hole at the bottom stopped up to prevent the wax entering. It was warmed up and molten wax poured round it and left to cool. This done, the result was a working instrument that was as handsome and practical as it was easy to make.

A tin or zinc horn would also serve. This could be made conical with the top slanting downward at about 50 degrees, and could be soldered straight onto the brass bridge-piece. No dimensions have been given in the drawing, as these will depend upon the size of the telephone receiver used. A good size of horn would be about 10 inches high and 4 inches in diameter.

NORMAN EDWARDS

How the Weather Does and Does Not Affect Radio

NEITHER wind nor rain have a bad effect upon radio transmission or reception; indeed, stormy weather is usually "good weather" from the point of view of the radio fan. Several common misconceptions on this subject are cleared up in the following contribution from an English correspondent:

What we commonly call good weather is not necessarily good weather for radio, and what we commonly call bad weather is not necessarily bad weather for radio. A dark, rainy day, for instance, is often an extremely good day for radio; indeed, it is during the stormy days of winter that most radio records are broken. The reason is that radio waves are entirely independent of air waves and of merely atmospheric disturbances.

Neither wind nor rain need have a bad effect on radio. The collection of moisture upon the insulators may cause a leakage of radio energy to the ground, but this is purely a mechanical fault that can be eliminated by the use of corrugated insulators. Radio waves do not constitute an electric current which flows down to the ground on the first convenient conductor. If a wind is so strong as to shake the antenna it may cause difficulty in tuning, but that is the only trouble a wind will give. The speed of the highest wind (one to two miles a minute) is so trifling compared to the speed of radio waves (186,000 miles a second) that even if an air wind could affect radio waves, the effect would not be appreciable.

There are three reasons why the conditions are not quite as favorable to radio work in summer as in winter:

First, the increased foliage of the trees brings about an increased absorption of radio energy, and this permits less of it to reach the actual antennas. Each tree acts virtually as an antenna, and the district becomes too "crowded" for good radio work.

Second, the brighter solar light in summer ionizes the atmosphere and causes a "dampening" of radio energy.

Third, there is more interference due to static in summer than in winter.

But even so, radio work can be carried on with success in summer. It is foolish to conclude that weather conditions at any time of the year can seriously interfere with radio. Last winter steamers off the coast of Colombia picked up American broadcasting from stations sometimes as far as 2,000 miles away! And the weather conditions in the tropics are infinitely more unfavorable all the year round than they are in the United States in summer!

Don't be discouraged about "summer radio." Take a set along with you on your vacation.

JOHN BULMER

A "HOME-MADE" OUTDOOR ANTENNA

By driving a nail into its top and bottom and making connections in the way that is shown above, any tree may be converted into an antenna that will actually work. And this antenna is the one kind that will be more efficient in summer than in winter, for the very foliage that is regarded as an "unfavorable" radio condition will make it absorb more energy.

* * *

How to Make a Spider-Web Coil from a Phonograph Record

HERE is a time- and money-saving hint from a practical-minded reader who made the spider-web coil that was described in detail in the October issue of POPULAR RADIO:

In the construction of this coil I discarded the composition sheet specified and I took an ordinary ten-cent phonograph record instead. I let this soak in hot water; then I made the cuttings that were required. (When the record is soft, this cutting can be made without cracking the record.) I then used it as the form on which to wind the coil. A phonograph record, as a form, has these three advantages: it insulates well; it is cheap and it is easily handled. A coil wound on it has a neat and workmanlike appearance.

WALTER H. SANDT

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service, and this sum must be enclosed with the letter of inquiry.*

QUESTION: Would a variable condenser help me any if it were used instead of the ordinary fixed condenser in the grid circuit of the vacuum tube detector? My set seems to be hard to keep from oscillating and although I can hear distant stations, reception is accompanied with a loud whistling sound.

E. JAMES EDSON

ANSWER: The variable condenser will enable you to tune out this whistling, due to oscillation, but it will add one more control to the set. However, as this will be necessary only in the case of tuning in the far-distant stations, you may leave this condenser set at a fixed value most of the time.

* * *

QUESTION: I am a beginner and would like to know a good hook-up for a crystal detector and a loose coupler.

J. B. EMERSON

ANSWER: You will find the circuit you require in Figure 5, page 212 of the November issue of POPULAR RADIO.

* * *

QUESTION: The diagram Figure 4, page 60, of the January issue of POPULAR RADIO, illustrates a circuit that shows three stages of radio frequency amplification, detector and two stages of audio frequency amplification. The coupling arrangement between the radio frequency amplifiers and the detector is a three-coil honeycomb mounting with suitable coils. I want to use this circuit, but I would like to eliminate the tickler coil L3, and use a variocoupler for the coils L1 and L2.

S. B. CROZIER

ANSWER: This modification should work well. If you have a variocoupler which has a tapped primary winding, you may also eliminate the condenser C3 and improve tuning.

QUESTION: Please give me the hook-up and particulars of the Flewelling super-regenerative circuit. I would like to know if it will work on an antenna and on a loop.

R. B. FOSTER

ANSWER: In the diagram (Figure I) you will find the circuit. The parts for the set are the following:

L1—honeycomb coil, L-50
L2—honeycomb coil, L-75 (a variocoupler may be used instead of coils L1 and L2.)
VC—variable condenser, .0005 mfd.
GC—grid condenser, .00025 mfd.
GL—grid leak, variable, 1 to 2 megohms
C1, C2, C3—mica fixed condensers, .006 mfd.
R1—low resistance, variable .25 to .75 megohms
R—filament rheostat 5 ohms
Tel.—telephones or loudspeaker
"A" and "B" batteries to suit tubes used.

Any type of hard tube may be used, including the 1½-volt filament tubes. All tuning is done in the same manner as is usual with the ordinary regenerative set. The variable grid leak GL plays a large part in tuning in and clearing up the signals. It will be best to experiment with the "B" battery voltage until the best voltage to use is found. This will vary between 22½ to 100 volts for the loudest results.

The set may be used with an antenna and ground if they are connected across the two wires marked XX on the diagram. The set may be used with either the antenna or the ground alone if it is connected to the upper wire X. If a loop is used it should be connected across XX. The set will function satisfactorily, however, up to distances of 50 miles without any antenna or ground of any kind.

A high pitched whistle will be heard in the telephones during reception, but this can be regulated and considerably reduced by adjusting the grid leak GL.

* * *

QUESTION: Does wind affect radio waves? I have noticed that during a heavy windstorm it is difficult to tune in, and keep tuned in, signals from broadcasting stations, especially the more distant ones. I have a single circuit regenerative receiver with two audio amplifier tubes attached to it.

F. R. SMYTHE

ANSWER: Wind does not affect the radio waves. They travel at the speed of light (186,000 miles a second) and the mile and a half a second of even a 90-mile hurricane would not have much effect against this great speed. Besides, the wind is a wind of *air*, and the radio waves pass through *space* and not through the air as a medium, so that there is no conflict between the two. What you are experiencing is a detuning of your single circuit receiver by the changes in capacity as your antenna swings in the wind. As it swings, the relative capacity varies, for the capacity of the antenna is inversely proportional to the distance between the antenna and the ground. In the type of receiving set that you are using, the antenna capacity plays an important part in the tuning and it is this that causes your signals to swing in and out.

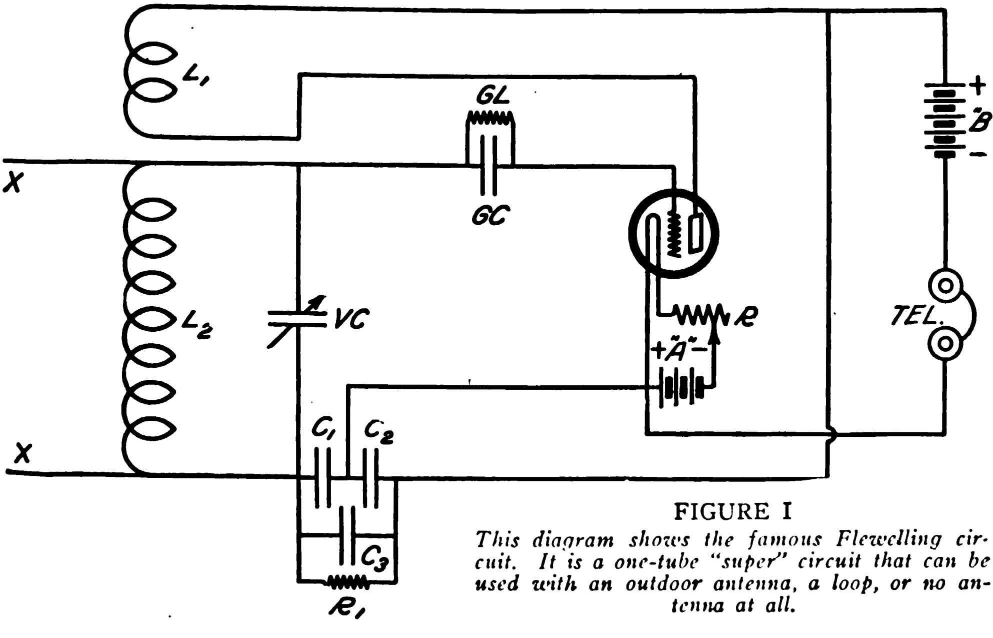


FIGURE I

This diagram shows the famous Flewelling circuit. It is a one-tube "super" circuit that can be used with an outdoor antenna, a loop, or no antenna at all.

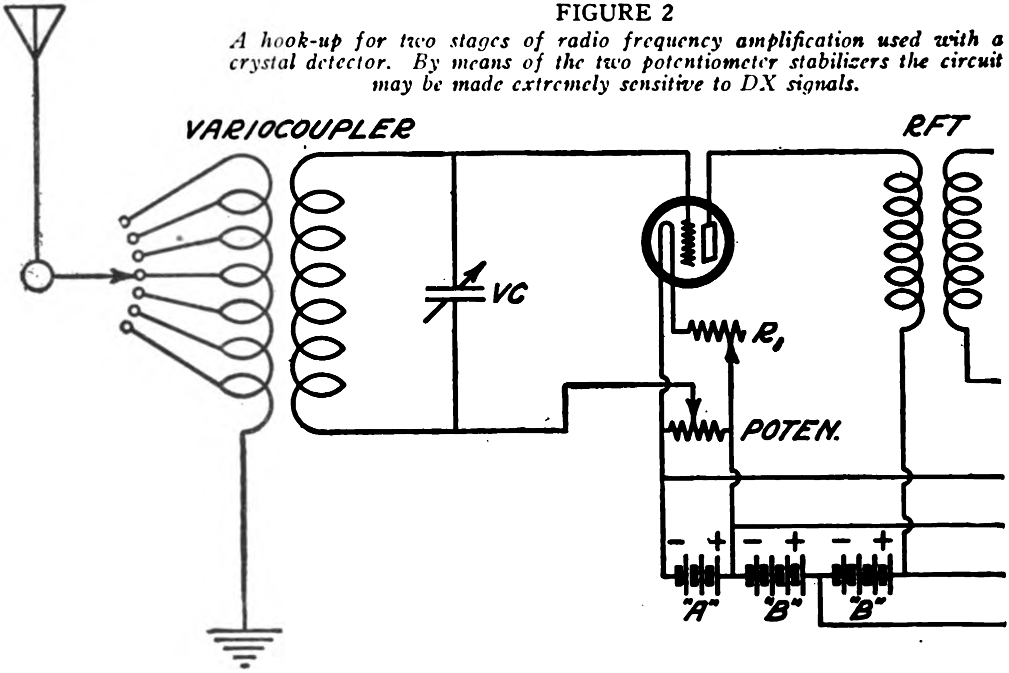


FIGURE 2

A hook-up for two stages of radio frequency amplification used with a crystal detector. By means of the two potentiometer stabilizers the circuit may be made extremely sensitive to DX signals.

QUESTION: I have bought the following apparatus and would like to get a circuit for two stages of radio frequency amplification with a tube detector:

2 Cunningham C-301 vacuum tubes.

1 Cunningham C-300 vacuum tube (for detector).

1 variable condenser, 43 plate.

1 Atwater-Kent variocoupler.

1 Dubilier grid leak and condenser combination.

1 pair of Brandes headphones.

2 Murad radio frequency transformers (for first and second stages).

Is there anything else I will need to have?

ROSCOE B. NETTE

ANSWER: The hook-up for your apparatus will be found in Figure 2. You will need also three filament rheostats, two potentiometers (200 to 300 ohms), three tube sockets, "A" and "B" batteries, and one fixed telephone condenser. If properly connected this set will bring in distant signals, but if you use a loudspeaker you should add to it two stages of audio frequency amplification.

* * *

QUESTION: I would like to get a diagram that shows how to hook up a standard regenerative circuit that uses a variocoupler, two variometers and a series condenser in the antenna circuit, with two stages of audio frequency amplification. I want to use jacks in each stage so that I can use the set with the detector alone, or with either one stage or two stages of amplification.

ARTHUR NILSON

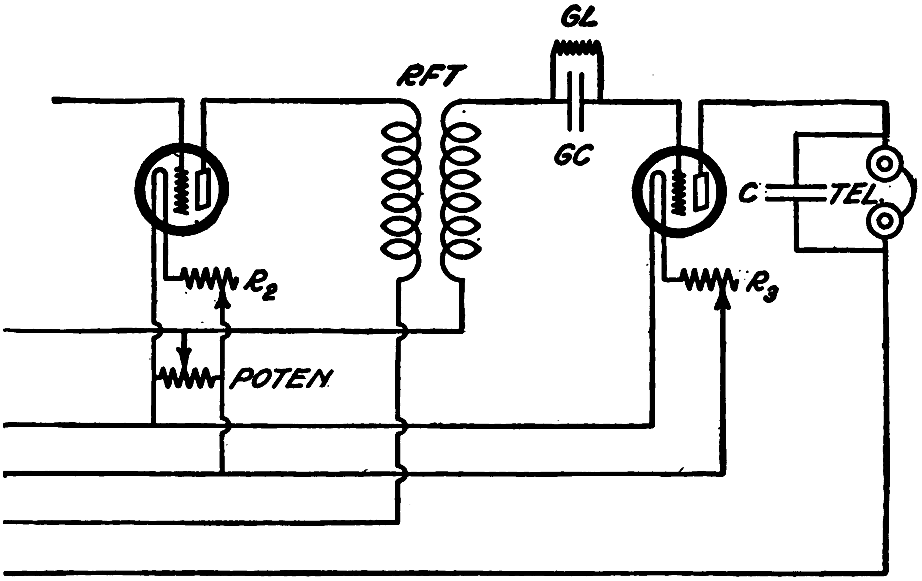
ANSWER: You will find this circuit given on page 210, Figure 3, in the November (1922) issue of POPULAR RADIO. This circuit has met with great favor among radio men; if you use the list of instruments given on the same page as the diagram, you will have good results in long-distance reception.

* * *

QUESTION: Will a potentiometer help me in regulating the "B" battery potential on my detector tube? How many ohms should it have? How should it be connected?

LAWRENCE VRELAND

ANSWER: This will be a good addition to your receiving set. It should be one of at least 200 ohms and should be connected directly across the "A" battery with its pointer connected to the negative terminal of the "B" battery. By rotating the lever arm a variation of six volts can be made in the potential of the "B" battery.



QUESTION: I have the following radio parts:

1 variocoupler
1 variometer
1 variable condenser, .001 mfd.
1 variable condenser, .0001 (vernier)
1 grid leak, 2 megs.
1 grid condenser, .00025 mfd.
1 telephone condenser
2 potentiometers, each 200 ohms

Will you give me a good regenerative hook-up for them?

T. E. REDMOND

ANSWER: The hook-up for connecting your instruments is shown in Figure 3. The two potentiometers are shown as P1 and P2, the grid leak and condenser as GL and GC, the large and small variable condensers as VC1 and VC2, and the variometer and telephone condenser as VAR, and C, respectively.

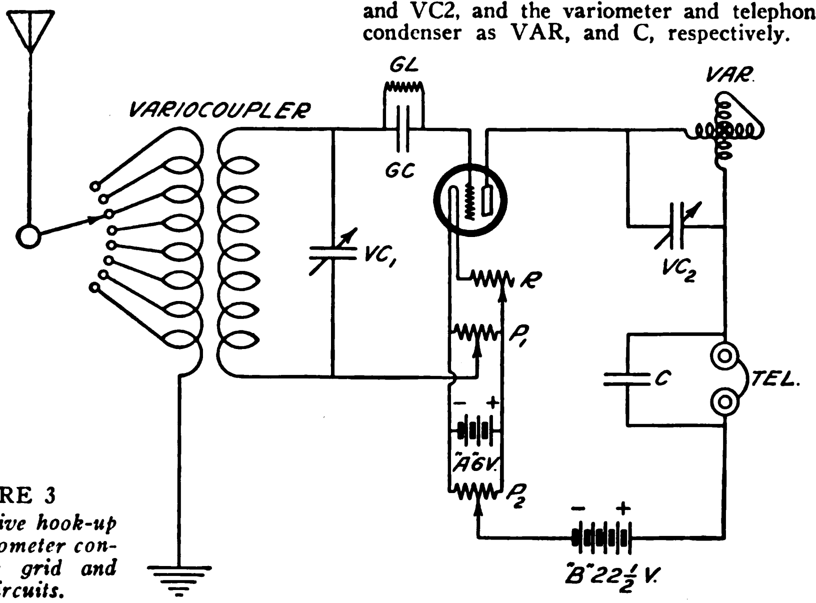
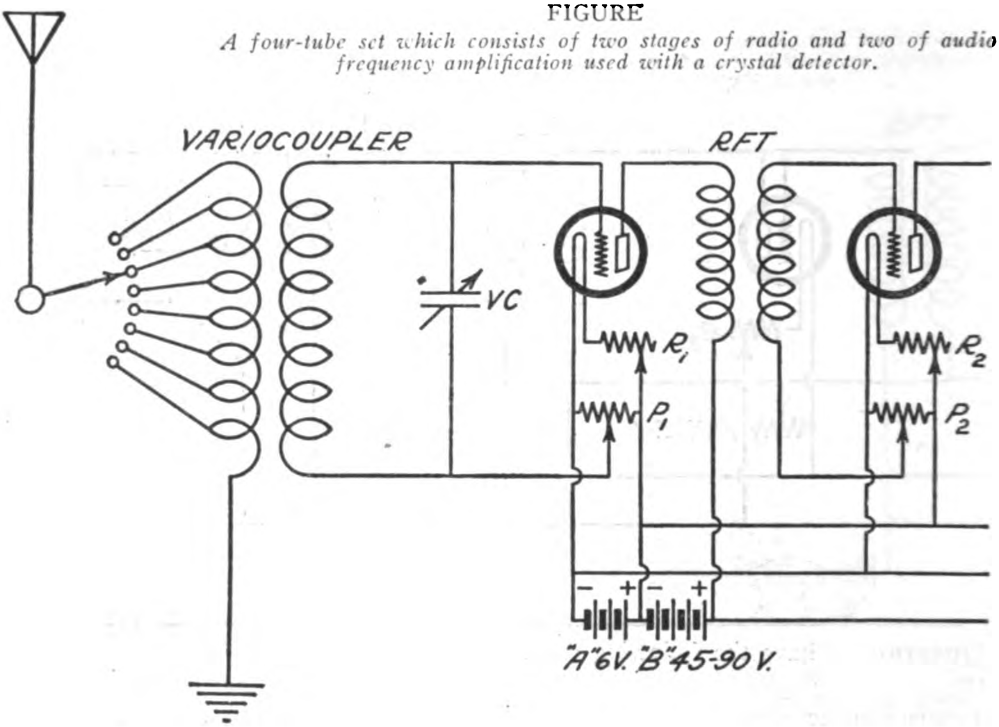


FIGURE 3

A regenerative hook-up with potentiometer control of the grid and plate circuits.



FIGURE

A four-tube set which consists of two stages of radio and two of audio frequency amplification used with a crystal detector.

QUESTION: Please give me a diagram for two stages of radio frequency amplification, crystal detector and two stages of audio frequency amplification. I would like to use a crystal detector, as it would cut down the number of tubes I have to use. I have some crystals that are sensitive over their whole surface and believe they would work if I had the proper circuit

SAM NEWBERRY

ANSWER: The hook-up you need is shown in Figure 4. The radio frequency transformers are designated as RFT, and the audio frequency transformers as AFT. Two potentiometers, P1 and P2 will be required, and these should have a resistance of 200 ohms each. The filament rheostats R1, R2, R3 and R4 are of five or six ohms each. The telephone condenser C should be of approximately .001 mfd. capacity.

* * *

QUESTION: What is the difference between a regenerative set and a non-regenerative set? How can a regenerative set be constructed out of a non-regenerative set?

C. PEARSON

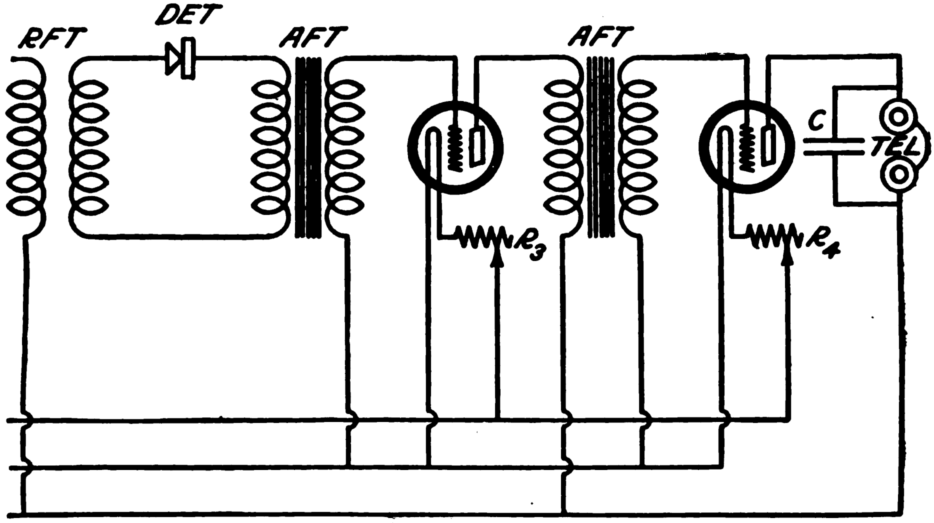
ANSWER: A regenerative set is one in which part of the received and amplified energy is fed back into the input circuit of the vacuum tube and regenerated or reamplified by passing again through the vacuum tube. In a non-regenerative receiver this is not so, the signals entering the input circuit only once. To make a regenerative receiver out of a non-regenerative receiver, insert a variometer in the plate circuit of the detector vacuum tube, so that the plate circuit may be tuned to approximately the same wavelength as the input circuit. Then part of the energy flowing in the plate circuit will be fed back into the input circuit, and the amount of this feedback may be controlled by turning the knob attached to the variometer.

* * *

QUESTION: On page 119 of the June issue of POPULAR RADIO you show a type of antenna called a loop antenna. I would like to know the dimensions of such an antenna.

W. H. MORRIS

ANSWER: We would advise you to build a square type loop. It should have a length of 3 feet to a side. For listening to broadcasting on 360 meters you should wind it with at least 15 turns of solid copper wire, bare or insulated, spaced ¼ inch between turns. Tuning will be accomplished by connecting a variable condenser across the loop.



QUESTION: Is it better to use the small or the large type of "B" batteries?

E. S. T.

ANSWER: If you have a single-tube set the ampere-hour capacity of the small type will be sufficient. If you use more than one tube with amplifiers it would be advisable to use the larger type, especially if you use more than 45 volts on one plate of the amplifier tubes.

* * *

QUESTION: I have a crystal detector set that consists of a variocoupler, a variable condenser, a crystal detector, a telephone condenser and a pair of telephones. Kindly show me how to add a variometer and a vacuum tube to it so that it will be regenerative. I would also like to keep the crystal so that I can switch to either crystal or vacuum tube.

ELINOR ROBINSON

ANSWER: The circuit shown in Figure 5 will give the results you require. You will, of course, require an "A" battery of six volts for the filament of the tube, and a "B" battery of 22½ volts for the plate. The switch shown in the diagram should be closed when using crystal and open when using the vacuum tube. When the crystal is being used, the filament of the vacuum tube should not be lit.

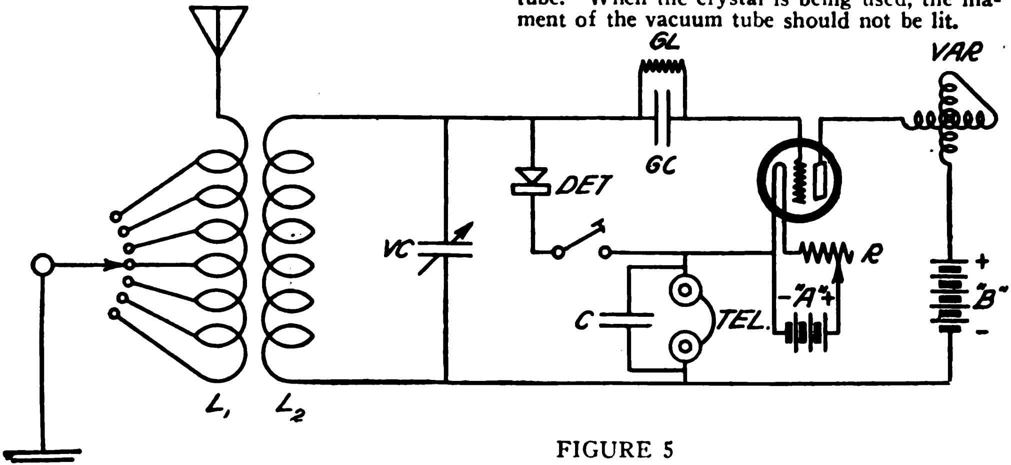
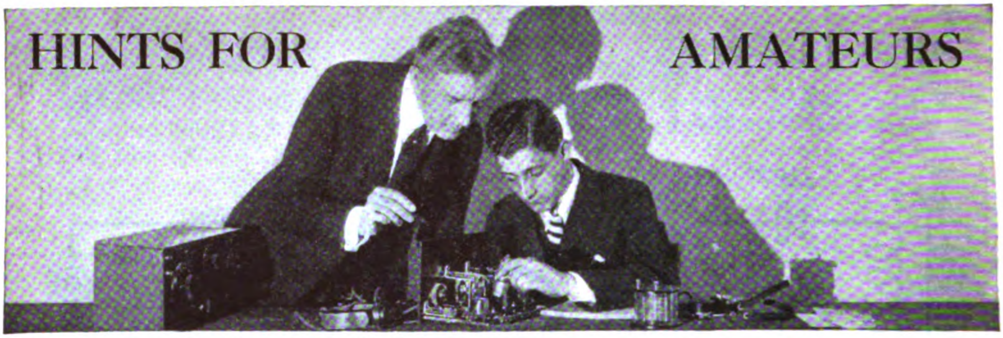


FIGURE 5

A single tube regenerative circuit with a crystal detector for standby use.

HINTS FOR AMATEURS



If you see a diagram and read a description of a radio set in a book and decide to build such a set, be sure to follow out every detail of construction. You may be sure that the design of the set has been carefully worked out and that the set has been tested before the description has been put into print.

Many novices try out a hook-up and build a set but use parts other than specified; when they get inferior results they blame it on the set. As a matter of fact they themselves are usually at fault. If you decide to follow instructions for this purpose, follow them down to the last detail; even then, if your success is not as great as you had hoped for, you may be sure that you have overlooked some detail which may have been all-important.

* * *

The ordinary telephone ear-piece is not suitable for use in a radio receiving set because its resistance is too low. To be most efficient a receiver should have a total resistance (impedance) equal to the circuit which is feeding it current. The resistance of the telephones that are used in radio vary from 2,000 to 8,000 ohms. The average resistance in the majority of makes is 3,000 ohms.

* * *

The lead-in for a radio installation should not be run at any great length through the interior of a building, as this will weaken the received energy on account of absorption by the building structure.

* * *

While listening-in to broadcasting, do not allow the detector in a regenerative-circuit receiver to oscillate. You can easily determine if it is oscillating by the high-pitched, whistling sound in your head telephones.

If a set is allowed to oscillate it will send out into space, *via* the antenna, a small quantity of radio energy that will cause the same sort of whistling noise

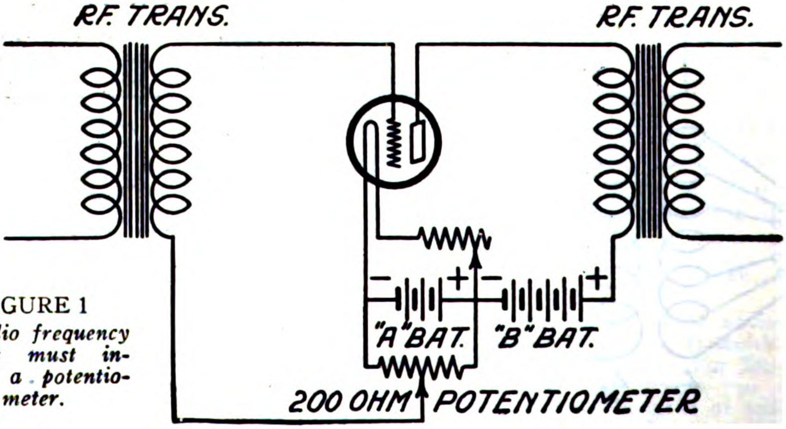


FIGURE 1
A radio frequency circuit must include a potentiometer.

in your neighbors' sets that you hear in your own telephones. There is no excuse, for anybody who knows this fact, for causing this radiation from regenerative receivers, as it will always be evident to the person who operates the receiver whether or not his set is oscillating.

* * *

WHEN experimenting with the radio frequency amplifier, the amateur should keep in mind the fact that the vacuum tube is a potentially operated device; that is, it is caused to function by the voltage applied to the grid. The grid should therefore be kept at a correct potential so that any incoming voltages that are impressed upon it make the greatest response in the plate circuit. This is most easily done by the use of a potentiometer shunted across the "A" battery. The adjustable pointer of the potentiometer allows this critical voltage to be applied to the grid with ease. A picture of a potentiometer is shown on this page, and the method of connecting it to the radio frequency amplifier is shown in Figure 1. Without this, the amplifier will be sure to function inefficiently.

* * *

WHEN the amateur builds his tickler feed-back circuit receiver he sometimes has trouble getting the set to oscillate. This trouble may be easily overcome by reversing the terminals of the tickler coil, as this is the fault most usually made. To find out which way to connect the tickler coil, tune in a signal the best you can; then reverse the terminals and retune the same signal. The comparison between the two strengths of the signals will give you the answer.

* * *

GOOD reception does not mean noise. A man may have a set that can be heard all over the neighborhood, but what good is mere volume of sound if it is incomprehensible? The two prime requisites of a good receiver are:

That it should tune sharply to eliminate interference.

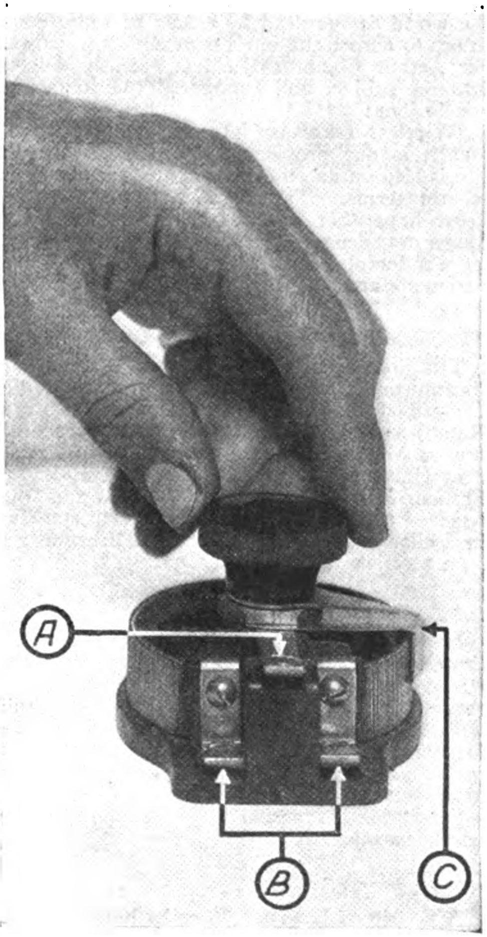
That it should reproduce signals with clarity and truthfulness.

A set that tunes in a signal and can be heard with comfort in a room with a loudspeaker and that can be clearly understood, is valuable, whereas a set that produces strident discords is useless.

When you buy your set, make sure that it will tune sharply and give a clear signal.

* * *

REMEMBER that the positive terminal of your "B" battery goes to the plate of the vacuum tube.



HOW TO CONNECT THE POTENTIOMETER

The terminal A (attached to the lever C) is connected in the grid circuit. The two terminals B are connected across the "A" battery.

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Will We Get Radio Signals from the Spirit World?

THE possibility of establishing contact with the world of the dead by means of radio continues to absorb the interest of the spiritualists. Sir Arthur Conan Doyle has recently delved into the subject and announced the following conclusions:

"Wireless takes us into an etheric region, and it is our provisional belief that psychic life is also on an etheric level and expressed in etheric terms. Therefore, I think there is great hope that wireless, possibly on a far longer wavelength, 30,000 meters say, may give us wonderful results. Several important experiments are progressing along this line."

* * *

The First Press Photograph Is Sent by Radio

THE invention of C. Francis Jenkins for transmitting and receiving pictures by radio (described in the April number of POPULAR RADIO) was given its most impressive practical test on March 3, when a photograph of President Harding was sent from the Naval Radio Station, NOF, in Washington, D. C., and was received at the station of the *Evening Bulletin* in Philadelphia. The picture was transmitted on a wavelength of 1,150 meters.

* * *

Amateur Sentinels in the Ether

IN order to co-operate with Uncle Sam in protecting radio, amateurs of the American Radio Relay League propose to appoint observing stations which will listen in and will log all interference that they hear. The information that they collect will be of help to the government in its determination to get after that peculiarly annoying radio nuisance—the station that insists upon "parking" on the wrong wavelength.

* * *

1,000 Voices Are Broadcast at Once

A RECORD of largest volume of human voices ever broadcast at one time was recently established when station WGY successfully transmitted the singing of the Albany Community Chorus, which is made up of 1,000 men and women.

A College Education at Home—by Radio

STILL another college is testing the possibilities of radio as a means of getting education to the public. The faculty of Marietta College in Ohio, has decided to broadcast a full set of its courses and to give regular credit toward a degree for courses taken in this way. It will be necessary for the radio student to register in the usual way, but aside from that he need not go from his own house.

* * *

Radio Enters a Stockholders' Meeting

THE first use of radio for reporting the proceedings of an important business meeting was made in Chicago on February 27, when the annual gathering of the stockholders of the Commonwealth Edison Company was broadcast for the benefit of the 25,000 owners and 600,000 customers of the concern. One stockholder who listened in on a small crystal set expressed surprise at the ease with which a $20,000,000 increase in capitalization was voted!

* * *

Radio on the Trail of a Dead Language

SCIENTISTS engaged in the study of Mayan, the prehistoric language of Mexico, found unexpected help in the new radio instrument, the pallophotophone, that makes photograph film records of sound. Dr. William Gates, Director of the National Museum of Guatemala, found an Indian who spoke Quiche, which is a direct offshoot of Mayan. He took him to Washington, where he made kymagraph tracings of his voice. Then he discovered that the pallophotophone could catch vibrations which the kymagraph could not possibly record. The Indian has gone back to his mountain home, but the records of his speech are still being studied. Already the scientists have discovered that Quiche is a tone language, akin to Chinese.

* * *

Radio Makes Song Birds Sing

ONE of the most remarkable concerts ever given occurred recently when the Detroit station WWJ put six canaries in front of its transmitter and made them sing—and sing on schedule time, at that! A microphone was placed in front of the cages, which were not moved from the accustomed positions. When the program was scheduled to begin a few notes were sounded on the piano, and the tiny artists at once burst into melody.

"We have a canary," wrote in one fan, "that did not know it could sing until WWJ began. He looked into the loudspeaker, twisted his head from side to side, and then started out."

* * *

Radio Warnings from the Jack Frost Country

THREE radio weather stations are to be set up in the MacKenzie Valley this summer by the Canadian Government. The MacKenzie Valley, Siberia, and Greenland are the three great cold centers of the world. One of the difficulties in predicting weather in the past has been the virtual impossibility of obtaining more or less simultaneous weather information from all sections of the earth, particularly from these three frigid areas.

* * *

John Bull Picks Up Yankee Jazz on an Indoor Loop Aerial

LISTENING for signals from American stations is an all-night job in England. Yet during the last few months station WGY in Schenectady has been flooded with letters from English fans who have picked up its broadcast programs. Perhaps the most remarkable instance of long-distance reception of this station is furnished by Captain Round, who heard the American station on a two-foot loop aerial. The Englishmen who listen for American stations have to be real enthusiasts; WGY's program, for example, starts at 7:45 in the evening—12:45 in the morning in London!

* * *

Radio Required on Airships

THE Commissioner of Air Traffic of Denmark has recently made a ruling that all airplanes operating in passenger service must carry radio apparatus as part of their equipment for emergency. This ruling extends the general custom of requiring ships to be so provided as a means of saving life.

* * *

Commands from an Invisible Drillmaster

THE feature of the U. S. Naval Academy's gymnkhana at Annapolis this year was a drill conducted by commands issued *via* radio. The midshipmen who made up the drill team wore the Ku Klux costume, but in each conical helmet was installed a small receiving set. While the spectators could hear no sound, the midshipmen went through their paces in their usual perfect unison.

* * *

A Combination Letter-and-Radiogram

THE postman and the radio operator now work together in a new system of communication that combines postal and radio service between France and her colonies. A letter may now be sent by mail to a radio station, transmitted to a receiving station in the colony, and from there sent by mail again to its destination—at a cost of only the postage at both ends plus two-thirds of the regular radio charge.

* * *

A Radio Wave That Rings a Bell

GERMAN scientists, experimenting with the tendency of radio waves to follow telegraph and telephone wires, announce an invention that enables a transmitting station to call by means of a bell some individual receiving station or group of stations. It is not inconceivable that "answering the radiophone bell" will be included among the duties of the housemaid.

* * *

Uncle Sam's Mail by Radio

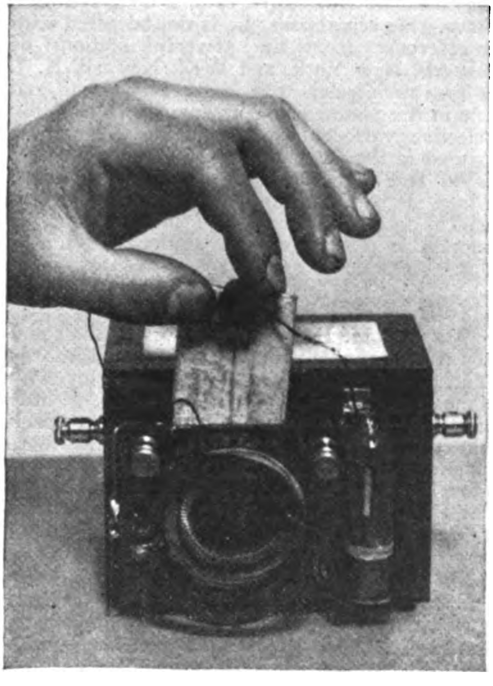
SIXTEEN radio stations are now in operation by the U. S. Post Office Department to aid the Air Mail-Service.

* * *

Gaston Blocks Fritz in the Ether

THE ancient grudge between France and Germany, having recently been settled on land, sea and in the air, is now being fought out in the ether. When a broadcasting station near Berlin recently started to send out news about the Ruhr situation, the Eiffel Tower station in Paris sent out such a long-continued howl as to prompt a Dutch newspaper to observe naïvely that "it must have been done purposely!"

* * *



ONE OF THE SMALLEST TUBE SETS IN THE WORLD

Some idea of its compactness is gained from the fact that the peanut tube is held in place by its grid condenser and the filament rheostat is concentric to the tuning inductance. It was made by a New York amateur, Frederic W. Proctor.

"STATIONS I HAVE HEARD"

If *you are getting good results with your receiving set, tell your fellow-readers of* Popular Radio *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* How You Are Using It.

HE USES THE FORBIDDEN THIRD STAGE OF AUDIO FREQUENCY

The often forbidden third stage of audio frequency in connection with one stage of radio frequency amplification is used by Carl C. Raymond of New York to pick up Davenport, Iowa. He reports that he is not bothered with interference from the powerful stations of WEAF, New York, and WJZ, Newark, N. J.

Two variometers, one in the grid circuit and one in the plate circuit, are used with a highly selective variocoupler. A variable condenser is used in the antenna circuit. The aerial used is 40 feet high and 160 feet long, with two wires. It points in the direction of Davenport, which accounts in a large measure for its success in picking up that station and tuning out the others.

* * *

REMARKABLE RANGE OF A CRYSTAL SET

Stanley M. Hadley, who lives in the country near Danville, Ind., says he can hear New York and Atlanta, Ga., on cold nights with almost nothing but a crystal and "a little perseverence." The only item in his set which he considers worth mentioning is his loose coupler, which he carefully soldered and mounted on hard rubber. He also hears Kansas City, Mo., Schenectady, N. Y., as well as nearer stations.

* * *

THIS FAN PREFERS HONEYCOMB COILS

A perfectly good two-variometer set was scrapped to make room for honeycomb coils by Arthur F. Dearborn of Elizabeth, N. J., with surprising results. His record with the variometers was a faint whisper from PWX at Havana; now he hears from St. Louis, Mo., Chicago, Ill., and Davenport, Iowa, with one tube.

Even with a variocoupler helping the variometers, they were not improved to any considerable extent, he insists. He is now using three honeycomb coils: primary, 25 turns; secondary, 35; tickler, 75. A 43-plate condenser is used across the primary and a 23-plate across the secondary. His aerial consists of one wire 110 feet long, strung 35 feet above the ground.

* * *

A TIN ROOF DOES NOT HANDICAP THIS SET

One dry-cell tube brings KYW, Chicago, to R. N. Trueman, of Brooklyn, N. Y., in spite of a tin roof and a long lead-in. He uses a variocoupler and one variometer.

His antenna is a single wire about fifty feet high at one end, but it runs down almost to the ground in order to gain its length of 110 feet. For almost half its length it runs six feet from the tin roof. The lead-in runs for forty feet inside the building, held about an inch from the walls by means of glass insulators.

Chicago is heard distinctly, he says, although his instruments are mounted temporarily on a board, and are not shielded from the capacity effects of his hands. Nearer stations are received loud and clear, although the powerful stations of New York and Newark, N. J., are somewhat hard to tune out.

* * *

HE VISITS 13 STATES *VIA* ETHER

A record of hearing 42 stations in thirteen states during his first two months of listening-in is reported by James A. White, of Cincinnati, O. He uses one storage battery tube and no amplification. His list includes WJZ, Newark, N. J., WGM, Atlanta, Ga.; WLK, Minneapolis, Minn.; WBAP, Fort Worth, Tex., and WNAC, Boston, Mass.

White uses a single-circuit regenerative hook-up with an aerial 120 feet long, strung at an average height of 40 feet above the ground.

HALF A CONTINENT ON A SINGLE TUBE

A TOTAL of 66 stations heard with one tube is the modest report of L. S. Hoskins of Rome, N. Y., who made the "Real DX Regenerative Receiver" designed by Laurence M. Cockaday for POPULAR RADIO and described in the January, 1923, number.

"I have never been stumped yet," writes Hoskins. "I can find something any time of the day. Whenever I find a good program, I put it on my loudspeaker through my other two tubes, rather than hunt for distant stations. Before I made the regenerative set I had heard only 13 stations. The rest of the 66 I caught in three weeks with my new machine."

His station log includes:

WAAF	Chicago
WAAK	Milwaukee, Wis.
WAAM	Newark, N. J.
WAAY	Youngstown, Ohio
WBAK	Harrisburg, Pa.
WBAN	Paterson, N. J.
WBAP	Ft. Worth, Texas
WBS	Newark, N. J.
WBT	Charlotte, N. C.
WBZ	Springfield, Mass.
CFCF	Montreal, Canada
CFCA	Toronto, Canada
WCAB	Newburg, N. Y.
WCAE	Pittsburgh, Pa.
WCAU	Philadelphia, Pa.
WCK	St. Louis, Mo.
WCX	Detroit, Mich.
WDAF	Kansas City, Mo.
WDAJ	Atlanta, Ga.
WDAL	Jacksonville, Fla.
WDAP	Chicago
WEAF	New York City
WFAF	Poughkeepsie, N. Y.
WFAG	Waterford, N. Y.
WFI	Philadelphia, Pa.
WGI	Medford Hillside, Mass.
WGL	Philadelphia, Pa.
WGM	Atlanta, Ga.
WGR	Buffalo, N. Y.
KOP	Detroit, Mich.
KSD	St. Louis, Mo.
KYW	Chicago
WLAG	Minneapolis, Minn.
WLAK	Bellows Falls, Vt.
WLK	Indianapolis, Ind.
WLW	Cincinnati, Ohio
WMAQ	Chicago, Ill.
WNAC	Boston, Mass.
WNAT	Philadelphia, Pa.
NOF	Anacostia, D. C.
WOC	Davenport, Iowa
WOH	Indianapolis, Ind.
WOO	Philadelphia, Pa.
WOQ	Kansas City, Mo.
WOR	Newark, N. J.
PWX	Havana, Cuba
WQAA	Parkersburg, Pa.
WRP	Camden, N. J.
WRW	Tarrytown, N. Y.
WSB	Atlanta, Ga.
WWJ	Detroit, Mich.
WGY	Schenectady, N. Y.
WHAS	Louisville, Ky.
WHB	Kansas City, Mo.
WHK	Cleveland, Ohio
WHN	Ridgewood, L. I.
WHAZ	Troy, N. Y.
WHAM	Rochester, N. Y.
WIAL	Norwood, Ohio
WIAO	Milwaukee, Wis.
WIP	Philadelphia, Pa.
WJAS	Pittsburgh, Pa.
WJAX	Cleveland, Ohio
WJZ	Newark, N. J.
WKAP	Cranston, R. I.
KDKA	East Pittsburgh, Pa.

WHY HE USES AN ANTENNA CONDENSER

THE chief reason that he hears PWX, Havana, Cuba, six times in one month is the use of a variable condenser in his antenna circuit, writes Henry O. Miller, of Philadelphia, Pa.

He has a one-tube regenerative hook-up which does not require a condenser in the antenna circuit, but *with it* he is able to tune out other stations broadcasting on nearly the same wavelengths at the same time. He also hears WDAP, Chicago, and WOC, Davenport, Ia.

* * *

PINE TREES AS AERIAL TOWERS

WITH only one tube Oscar E. Johnson, of Indianapolis, Ind., is able to pick up fifteen to twenty stations almost any night. He uses a small inductance coil shunted by a variable condenser in his plate circuit.

Two pine trees about 100 feet high support his antenna. They are 130 feet apart and stand on the top of a small hill. Two wires are strung between them, with insulators spaced six feet from the nearest branches, and the lead-in is fastened to one end.

* * *

REMARKABLE RESULTS FROM A CRYSTAL SET

USING electric light wires for an aerial and a vacuum tube with his crystal in a reflex circuit, Joseph M. Ambrose hears Chicago in Louisville, Ky. Experimenters seldom go to so much trouble to use a crystal, but Ambrose thinks his set is as good as the ordinary three-tube receiving set.

* * *

HE SPANS THE CONTINENT WITH A LOUD-SPEAKER

BROADCAST music from San Francisco comes in clear on the loudspeaker of R. N. Borden, of Pittsburgh, Pa. He uses a regenerative hook-up with two stages of audio frequency and two stages of radio frequency amplification. His aerial is made of two strands of wire 35 feet high and 90 feet long.

* * *

ADVANTAGES OF A SINGLE CIRCUIT

MYRON SELFRIDGE, of Atlanta, Ga., hears practically all of the New York stations with a single circuit tuner, one tube, and a two-wire antenna, 45 feet long.

* * *

RECEIVING LONG-DISTANCE ON A DOOR

UNABLE to erect an antenna on his roof, John A. Spear has made an efficient loop aerial on a door of a clothes closet. He opens or closes the door so that the aerial will point toward the station he wishes to hear, and with two stages of radio frequency amplification he brings New York stations into his Chicago room almost loud enough to operate a loudspeaker.

The aerial is made of 75 feet of the ordinary seven-strand antenna wire for sale at most radio stores, and is held about an inch from the door by porcelain insulators. His set is grounded on a steam radiator.

FROM NEW HAMPSHIRE TO CALIFORNIA ON A DETECTOR TUBE

A DETECTOR tube alone, in a single circuit, can reach from Newfields, N. H., to Los Angeles, Calif., according to Russell Sheehy. He made his set himself, and during the last six months he has heard 144 stations in 38 states, Cuba, Porto Rico and Canada. His record shows 16 stations in New York, 15 in Pennsylvania, eight in Texas and seven in Ohio (and it might be added) one in his own state, New Hampshire.

* * *

A ROCKING-CHAIR TOUR TO SEVENTEEN CITIES

DAVID R. NEWMAN of Hoboken, N. J., submits his distance record for one evening of rocking-chair traveling, and sets down the time when he arrived at 17 different cities, using one dry-cell tube and a crystal detector in a reflex circuit. His list is:

7:18	WDAP	Chicago
7:21	WJZ	Newark, N. J.
7:33	WDAL	Jacksonville, Fla.
7:39	WFI	Philadelphia, Pa.
7:52	WEAF	New York City
7:57	WOC	Davenport, Ia.
8:07	WCAE	Pittsburgh, Pa.
8:18	WSB	Atlanta, Ga.
8:22	WHN	Ridgewood, N. Y.
8:30	WWJ	Detroit, Mich.
8:39	WHAS	Louisville, Ky.
8:52	WGY	Schenectady, N. Y.
8:54	CFCA	Toronto, Canada
8:57	WGR	Buffalo, N. Y.
9:08	WJAX	Cleveland, O.
9:17	WCK	St. Louis, Mo.
9:21	WOQ	Kansas City, Mo.

Newman used an outdoor antenna made of two strands, 120 feet long, at an average height of 35 feet from the ground.

* * *

LONG DISTANCE ON A CRYSTAL SET

LONG distance work with a crystal set is reported by James A. Jefferson, of South Bend, Ind., who listens in on WJZ, Newark, N. J., and WEAF, New York, almost every clear night. He hears WSB, Atlanta, Ga.; WGY, Schenectady, N. Y.; KDKA, Pittsburgh, Pa.; WWJ, Detroit, Mich.; WOC, Davenport, Ia., and WHB, Kansas City, Mo.

Jefferson is fortunate to have a tower for his antenna, and no landlord to kick about it. The tower is 70 feet high, and his two-wire antenna runs a distance of 125 feet to the roof of his home, which is 40 feet high. In his fifth month of "radio fanning" he is still proud of his loose coupler which he made from directions printed in POPULAR RADIO, and he sees no reason for using more expensive apparatus.

* * *

THIRTY IN TWO NIGHTS

THIRTY stations in two nights is the record of A. H. Bosworth, of Los Angeles, Calif., who uses a regenerative circuit with two stages of amplification. In addition to practically all of the larger stations of the western coast he hears WGM, Atlanta, Ga.; WIP, Philadelphia, Pa.; WBAP., Fort Worth, Tex.; KDYY, Denver, Colo., and a station in Salt Lake City, Utah.

He was satisfied with less than a dozen stations and thought his set was working well when by accident he learned that tuning is a gentle art. Concerning tuning, he says:

"I had heard that a movement of a hundredth of an inch or less would sometimes tune a station in and out, but had no idea that my own set was so sensitive until experience forced this upon me. Since then, I have acquired a more gentle touch and a great respect for the man who can really tune his set."

* * *

A LONG-DISTANCE BED

NEXT to the magic carpet comes the enchanted bedsprings as a means of traveling through the air from one city to another. Several have told of their exploits with this new antenna, notably A. R. Goldberg, of New York, who, in the third story of a seven-story apartment house, hears Pittsburgh, Pa., with but one tube.

A range of two or three hundred miles is not infrequent with such a combination, as it is often quite as good as an indoor loop or one of the plugs made to fit in a light socket.

* * *

TWO STAGES OF AMPLIFICATION COVER THE UNITED STATES

Two stages of audio frequency amplification have covered the United States for L. M. Stephenson, of Phoenix, Ariz., when used with a regenerative hook-up of the two-variometer type. A variable condenser is used across the secondary coil of the variocoupler with another in the antenna circuit, and these are highly praised by Stephenson for their help in delicately tuning-in distant stations. An outstanding feature of the set is the large number of combinations which can be used for tuning to any particular station. When one station interferes, it is almost always possible to shift the dials to new positions, where the interference diappears.

Among the stations he has heard are WEAF, New York, WSB, Atlanta, Ga., KYW, Chicago, KFAF, Denver, KZN, Salt Lake City, KFDB, San Francisco, and KYG, Portland, Ore.

* * *

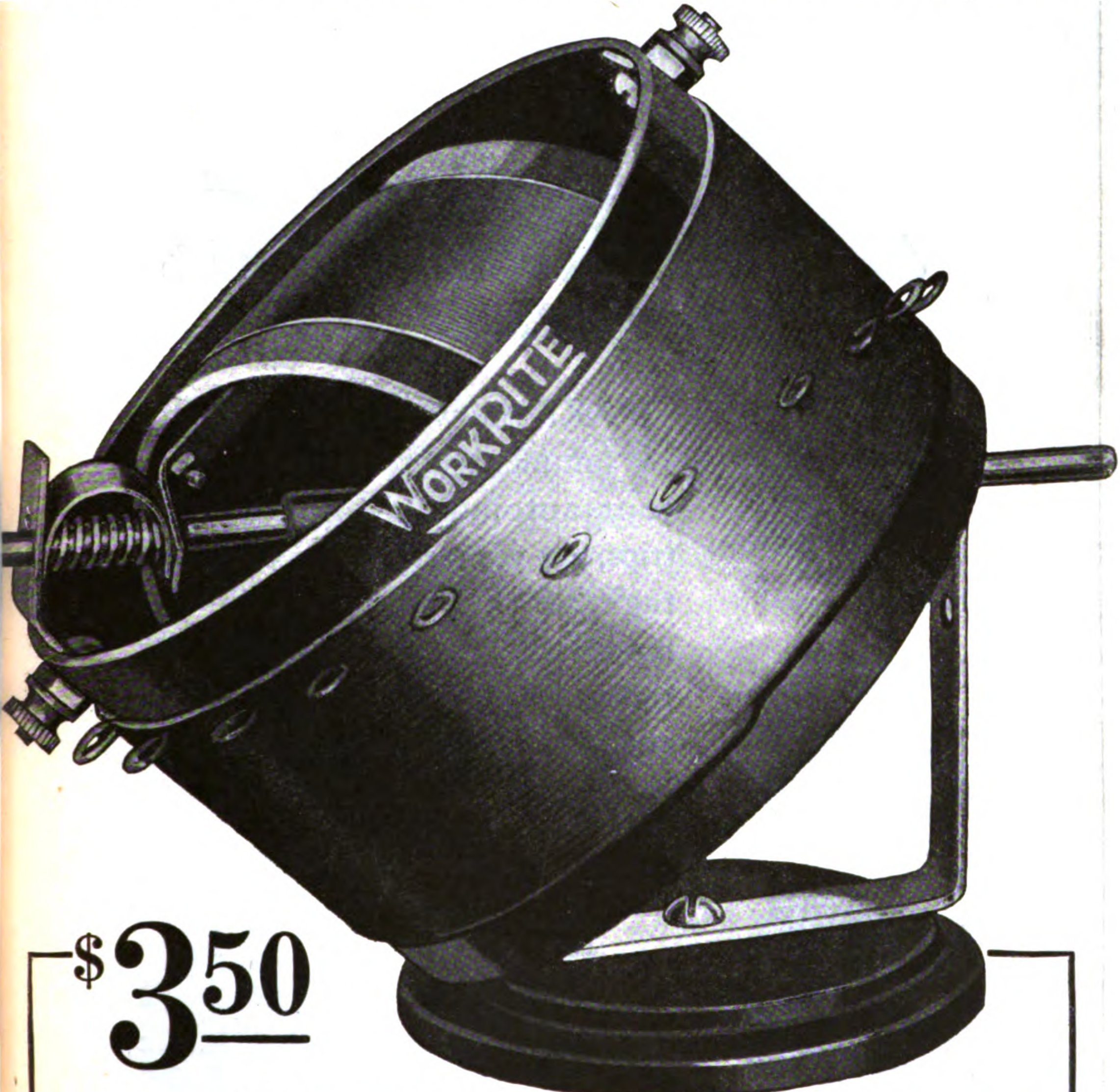
HE INCREASED HIS RANGE WITH A WOODEN VARIOMETER SHAFT

THE operator who gets down to the fine points of tuning is constantly hunting for "stray capacity," such as that caused when the human body comes close to a receiving set, and Walter E. Jacket, of San Francisco, has happily discovered the drawback of a metal variometer shaft.

He first mounted his variometer four inches behind the panel of his set, to keep it farther away from his hand while he was tuning. This helped a little, but to make a good job he cut out a piece of the metal shaft and inserted a small rod of wood. His range was increased from 200 to 2,000 miles. He used to hear only local stations, but now he hears Chicago stations, as well as practically all of the stations on the Western coast.

"WORKRITE"

180° SUPER VARIOCOUPLER



$3.50

One of these WorkRite 180° Super Variocouplers made from moulded Bakelite and two WorkRite Super Variometers made from mahogany make up the "WorkRite Tuner Team"—the most selective circuit possible.

A year ago the price of these instruments was $6.00 each. Due to our enormous production you can now buy them for $3.50 each. Order a set today. And remember that

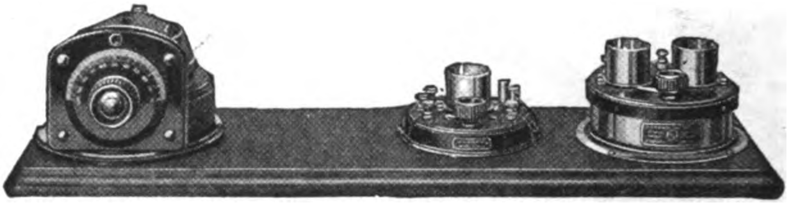
WORKRITE RADIO PARTS WORKRITE

THE WORKRITE MANUFACTURING CO.

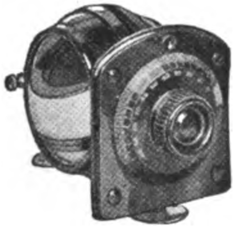
(Branch Office, 2204 Michigan Ave., Chicago) 5509 Euclid Avenue, Cleveland, Ohio

ATWATER KENT

Receiving Sets and Parts



Complete Set, consisting of Coupled Circuit Tuner, Detector Unit and 2-stage Amplifier

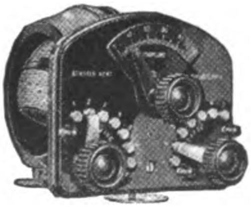


Mounted Variometer

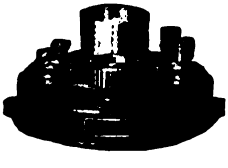
Type 11 Tuner

TAKE the world with you this summer wherever you go. On your automobile and yachting trips, to your camp, or your cottage at the shore or in the mountains. An Atwater Kent radio set will bring you music, reports, time signals, baseball scores—the world's news.

Atwater Kent products sell on appearance.



Mounted Variocoupler



Detector Unit

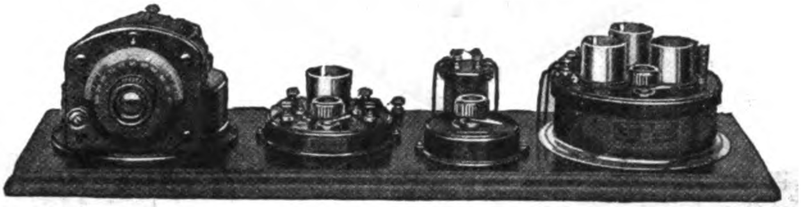
1-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY

4933 Stenton Ave. *Radio Dept.* Philadelphia, Pa.

ATWATER KENT

Receiving Sets and Parts

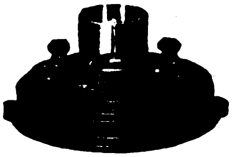


Complete Set, consisting of Type 11 Tuner, one stage of Radio Frequency Amplification, and Detector 2-stage Audio Frequency Amplifier

ATWATER KENT sets and parts are ideal for summer use due to their compact and rugged construction and the fact that they are moisture-proof. They are made mostly of condensite with all metal parts thoroughly water-proofed.

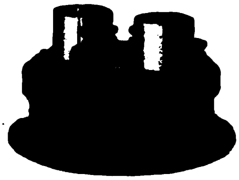
R. F. Transformer

You will find ATWATER KENT radio equipment ideal for summer use.

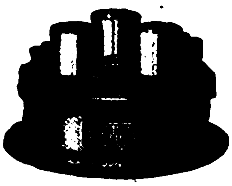


Standard Vac. Tube Unit

They stay sold on quality of performance.



2-stage Amplifier. A similar unit is furnished in a Detector 1-stage Amplifier

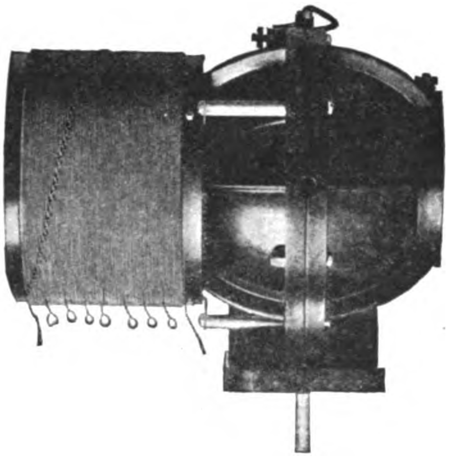


Detector 2-stage Amplifier

Potentiometer
Also made for panel mtg.

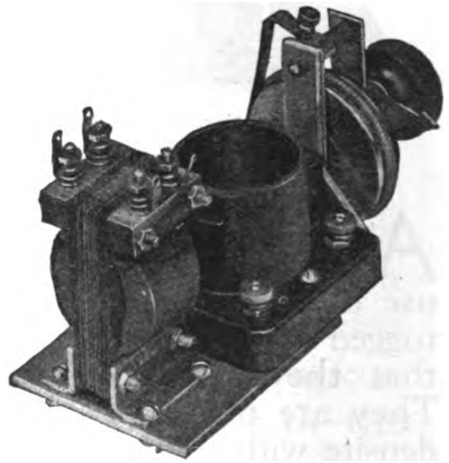
ATWATER KENT MANUFACTURING COMPANY
4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

SE-AR-DE



No. 165..............................$13.00

SE-AR-DE RADIOMETER WITH B. W. INDUCTANCE

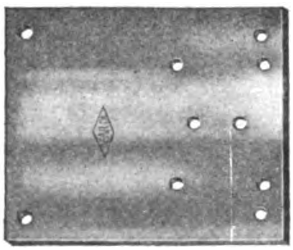


No. 197 AMPLIFYING UNIT........$10.50

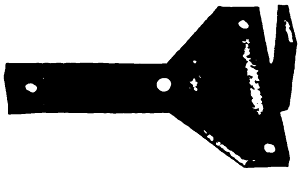
FEDERAL TRANS.

No. 198 AMPLIFYING UNIT.........$7.50

ACME TRANS.



No. 196 TRANSFORMER MOUNTING PLATE...........................$0.10



No. 195 SOCKET MOUNTING BRACKET.........................$0.15

R. MITCHELL & CO.

255 Atlantic Ave. **Boston, Mass.**

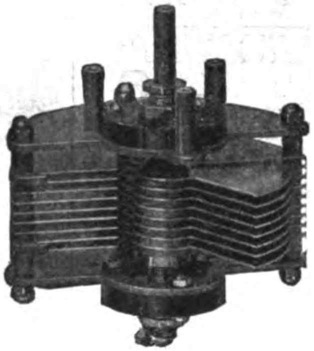
For 47 years Manufacturers of Scientific and other equipment

Look for trade mark on every piece

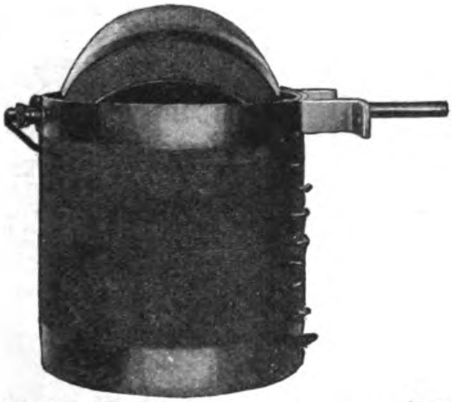
Jobbers and Dealers write for discounts

SE-AR-DE

No. 146 RADIOMETER...............**$8.00**
MOLDED BAKELITE



No. 185 VARIABLE CONDENSER....$4.25
CAP. .00035 M. F. 17 PLATES



No. 167 COUPLER.............. ....$5.50

No. 164 KNOB AND DIAL...........$0.75
MOLDED BAKELITE

R. MITCHELL & CO.

255 Atlantic Ave. **Boston, Mass.**

For 47 years Manufacturers of Scientific and other equipment
Look for trade mark on every piece

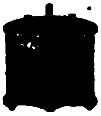
Jobbers and Dealers write for discounts

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

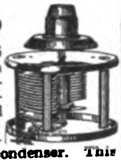
BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS



D812—43 plate .001 Mfd. $1.73
D813—21 plate .0005 Mfd. 1.43
D814—11 plate .00025 Mfd. 1.32
D815—3 plate Vernier 98c

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

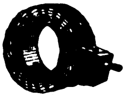
COMBINATION VERNIER VARIABLE CONDENSERS



D824—23 plate .0005 Mfd. Price $2.89
D826—43 plate .001 Mfd. Price 3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning High-grade design and construction. Finely finished. Suitable for panel mounting.

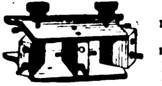
INDUCTANCE "HONEY COMB" COILS



Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Meters	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	D301	$0.39	D321	$0.89
35	175- 450	D302	.42	D322	0.95
50	240- 720	D303	.49	D323	1.04
75	390- 910	D304	.54	D324	1.08
100	500- 1450	D305	.58	D325	1.13
150	600- 2000	D306	.63	D326	1.17
200	900- 2500	D307	.72	D327	1.26
250	1200- 3500	D308	.78	D328	1.35
300	1500- 4500	D309	.82	D329	1.36
400	2000- 5000	D310	.97	D330	1.57
500	2800- 6100	D311	1.12	D331	1.63
600	4000-10000	D312	1.27	D332	1.78
750	5000-12000	D313	1.43	D333	1.93
1000	7900-15000	D314	1.70	D334	2.28
1250	9750-19500	D315	1.92	D335	2.49
1500	14500-26500	D316	2.18	D336	2.65

COIL MOUNTINGS



D340 Three coil mounting $3.95
D341 Two coil mounting 2.95

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. D732 Each.............59c

This Guarantee Protects You. Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

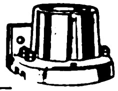
D105 Detector. Each.....$4.45
D110 Amplifier VV200 or C300 Each......... 5.95
D112 Amplifier VV201A or C301A Each 5.95
D115 5 Watt Transmitter........... 7.70
D107 WD 11 1½ volt.............. 5.95
D109 WD 11 adapter. Each ... 48c

VACUUM TUBE SOCKETS

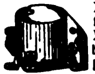
Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs

D140 For Standard Base Tubes. Each 39c
D108 For WD 11 Tubes. Each 49c

PORCELAIN BASE AND TUBE



D144 Crosley for either panel or table mounting for Standard Base...36c



High Grade combination type for panel or table mounting. Metal tube. Highly insulated base. For Standard Base Tubes D146 Each...............45c

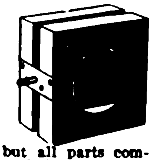
GRID CONDENSER

D162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF.........14c
D163 Same as 162 but higher grade. Enclosed in metal case......39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
D100 Each...........19c

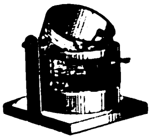
VARIOMETER



D410—Completely assembled, price $2.69 Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.

D411—Not assembled but all parts complete, except wire, including winding form $1.48

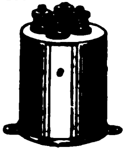
VARIO-COUPLER



With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

D415 Price, completely assembled $2.45
D416 Not assembled, but all parts complete. Price, except wire $1.18
D417 Rotor ball only. Each........29c
D406 Bakelite Stator tube only. Each 35c

RADIO FREQUENCY AMPLIFYING TRANSFORMER



D995 Each..........$3.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

D234 10 to 1 Mounted. Each......$3.48
D235 10 to 1 Unmounted. Each.... 2.65
D236 3 to 1 Mounted. Each...... 3.40
D237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

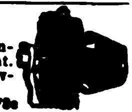
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
D130 Each...............45c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
D132 Each................45c

POTENTIOMETER

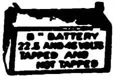
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
D133 Each..................................98c

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
D135 Each..............79c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

D180 Signal Corps type, small size, 15 cells. 22½ volts. Each, 95c.

D184 Variable Large Navy size. 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each...............$1.89

D188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

DETECTOR CRYSTALS CAREFULLY TESTED

D736 Galena, Arlington tested, per piece 19c
D738 Silicon, Arlington tested, per piece 19c
D735 Tested, Galena, per piece........ 9c
D737 Tested, Silicon, per piece........ 9c

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
D240—100 ft. coil 49c
D242—500 ft. coil $2.35

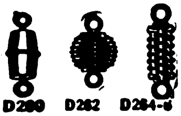
Solid Bare Copper Wire, size 12
D244—100 ft. coil 67c
D246—500 ft. coil $3.06

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

D248—100 ft. coil 72c
D249—500 ft. coil $3.20

ANTENNA INSULATORS

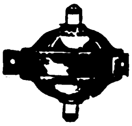


D260 D262 D264-6

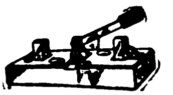
D260 Size 1x3¼. Two for.......17c
D262 Size 2⅛x3¼. Two for.......55c
D264 Size 1½x4. Two for.......69c
D266 Size 1½x10½. Two for $1.28

OUTDOOR LIGHTNING ARRESTER

D980 Price.........$1.58
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.



PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

D385 Single Pole Single Throw. Each 20c
D383 Single Pole Double Throw. Each 32c
D384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

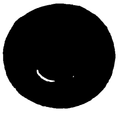
Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

D380—1" Radius
D381—1¼" Radius
D382—1½" Radius
Each 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
D386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB



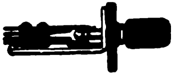
Moulded of highly polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

D900 2¾" Diam. for 3-16" shaft. Ea..19c
D901 2¾" Diam. for ¼" shaft. Ea....19c
D904 3" Diam. for 3-16" shaft. Ea.....25c
D905 3" Diam. for ¼" shaft. Ea......25c
D906 3½" Diam for 3-16" shaft. Ea...35c
D907 3½" Diam. for ¼" shaft. Ea....35c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS



Finest grade jacks. Improved design. Best materials Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only
D390 Open circuit. Each.....43c
D391 Closed circuit. Each...49c
D392 Two circuit. Each......60c
D393 Single-cir. fila. control..69c
D394 Two cir. fila. control..85c

D395 Plug. Large space with set screws for attaching cord. Each.............49c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts.

D387 Open Circuit Jack. Each......27c
D388 Two Circuit Jack. Each......35c
D389 Standard Plug. Each..........35c

BINDING POSTS

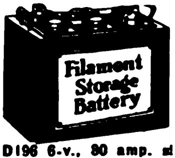
D370-2

Brass, polished nickel finish. Washer and 6-32". screw extending ⅝"....
D370 Large size—barrel and knob ¾" long, dozen 85c
D372 Smaller size—barrel and knob 9-16" long. dozen 70c

D376-8

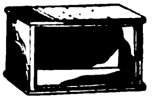
D374 Large size with composition knob. dozen 50c
D376 Large size with hole for phone tip or wire, dozen.......................80c
D378 Small size with hole for phone tip or wire, dozen.......................35c

STORAGE BATTERY



A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.
D194 6-v., 40 amp. size. Each..$10.00
D196 6-v., 80 amp. size. Each....$12.50
Price does not include transportation.

CABINETS



Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

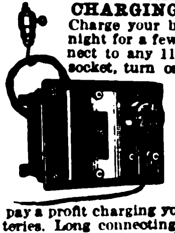
Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	D420	$2.48
6x10½"	5½"	10"	7"	D422	2.75
6x14"	5½"	13½"	7"	D424	3.30
7x14"	6½"	13½"	7"	D423	3.60
7x18"	6½"	17½"	7"	D426	3.90
7x21"	5½"	20½"	7"	D425	4.20
9x14"	8½"	13½"	10"	D428	3.70
12x14"	11½"	13½"	10"	D430	4.40
12x21"	11½"	20½"	10"	D432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x7	D450	$0.50	D460	$0.75	D470	$0.98
6x10½	D451	.75	D461	1.18	D470	1.47
6x14	D452	1.05	D462	1.55	D472	2.05
7x14	D458	1.20	D468	2.60	D478	2.40
7x18	D453	1.55	D463	2.30	D473	3.10
7x21	D457	1.78	D467	2.65	D477	3.60
9x14	D454	1.60	D464	2.30	D474	3.10
12x14	D455	2.10	D465	3.10	D475	4,15
12x21	D456	3.15	D466	4.65	D476	6.20

HOME CHARGER BATTERY CHARGING RECTIFIER



Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. **Prices are Transportation Paid.**
D201 For 6 volt battery..........$13.95

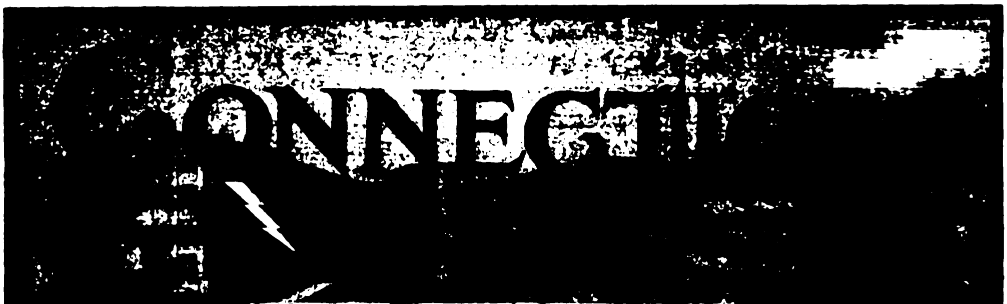
BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.
D770—2000 ohm......$3.75

OTHER STANDARD BRAND HEADSETS

D751 Murdock 56, 2000 ohm........$4.20
D752 Murdock 56, 3000 ohm....... 4.95
D764 Frost, 2000 ohm............ 4.20
D766 Frost, 3000 ohm............ 4.85
D756 Red Head, 3000 ohm......... 5.85
D758 Western Electric, 2200 ohm.. 9.50
D754 Baldwin Type C with universal jack plug $12.00
D755 Baldwin Type C unit....... 5.50
D768 Brandes, 2000 ohm......... 6.95

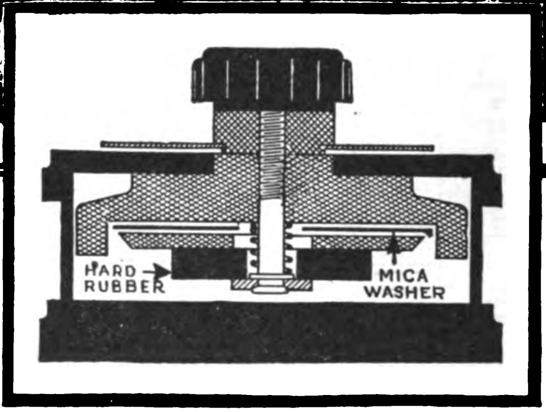
THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.



Finer adjustments

Better selectivity

Greater signal strength



Simple as the symbol that stands for it

The Secret of Its Efficiency

It is a well-known fact that losses in radio condensers take place in the solid insulating material used in their construction.

And it is equally true that a condenser increases in efficiency of signal reproduction as its losses decrease.

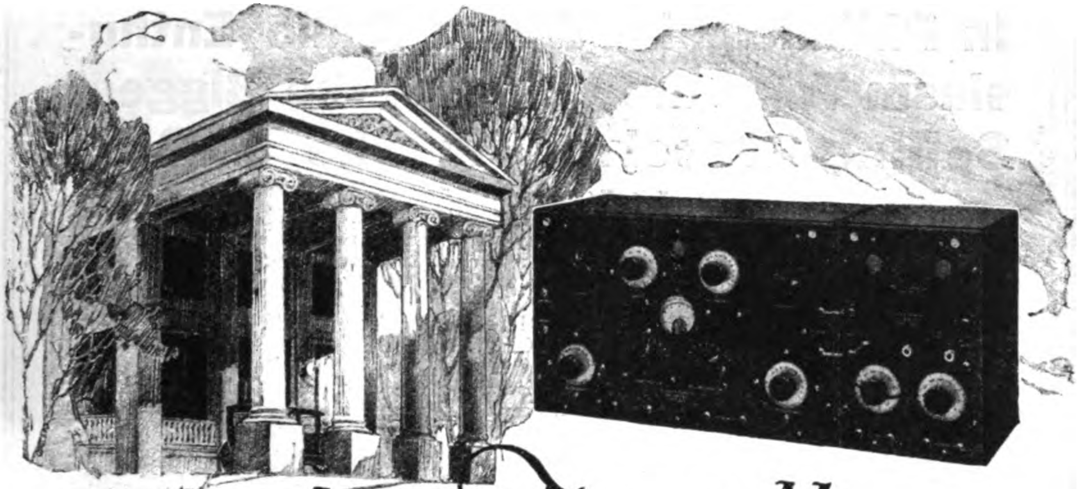
The Connecticut Variable Condenser not only employs the two best insulating materials known—mica and hard rubber—but the smallest possible amount of each. This, then, is the reason for its extremely low resistance—0.2 ohm—as well also the secret of its high efficiency at short wave lengths.

Descriptive bulletin 100-F upon request

Panel type, J-108, $5.00

Portable type, J-107, $6.00

CONNECTICUT **TELEPHONE & ELECTRIC** **COMPANY**
MERIDEN RADIO DIVISION **CONNECTICUT**



In the Finest Homes

IT IS but natural that Kennedy Receiving Sets are found in the finest homes. The same appreciation of artistry that is responsible for beautiful home surroundings sees in a Kennedy a fitting example of craftsmanship that belongs with the finest.

Again—the clarity of reception, freedom from extraneous noises, and greater elimination of interference made possible by a Kennedy appeals to the true lover of music and the finer things of life. The long range places the music of the continent within your reach.

And last—the owner of a Kennedy knows that others will admire it. Its possession reflects good taste and judgment.

Arrange with your local dealer for demonstration, or write us direct for descriptive literature.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

That the Kennedy "Universal" set is a wonderful example of mechanical excellence is shown by this interior view. It can be made to detect, regenerate or oscillate over its entire range of 200 to 25,000 meters.

All Kennedy Regenerative Receivers are licensed under Armstrong U. S. Patent No. 1,113,149.

KENNEDY

The Royalty of Radio

In Philadelphia, Where Radio Enthusiasm Tops the Country, the Biggest Selling Receiver Is the S-P-2!

Distributors for

Lyradion Sales & Eng. Co.
Sleeper Radio Corp.
Jewett Mfg. Corp.
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Pacent Elec. Co.
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Elec. Prod. Mfg.
Penn Radio
Atwater Kent
Homecharger
Radisco
Electrose
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Callophone
Amer. Radio & Research Corp.
Baldwin Radio
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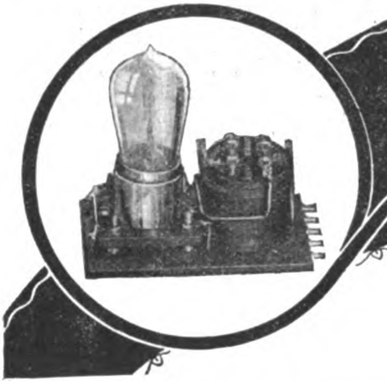
WHOLESALE ONLY

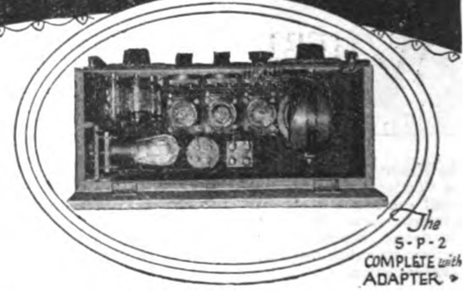
The S-P-2 is truly the SUPERIOR RECEIVING SET on the market today and has been proven far and away in a class by itself, excelling any regenerative receiver now offered costing $125.00 to $180.00.

THE LIST PRICE IS BUT $85.00 WITH AN ADDITIONAL CHARGE OF $15.00 FOR THE ADAPTER.

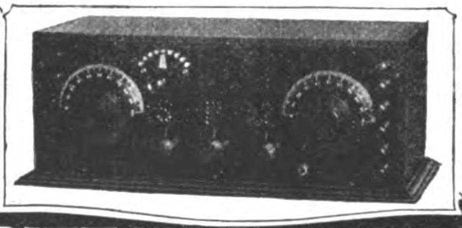
The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.





The S-P-2 COMPLETE with ADAPTER



Write for Big, New Catalogue No. 102A Price 20c

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Ave. Pittsburgh, Pa.

BELL TELEPHONE
GRANT 3632

Magnavox on the Veranda of
the Country Club

WHERE radio apparatus, like a professional entertainer, must meet the test of satisfying really discriminating people, a Magnavox Reproducer and Power Amplifier (as shown above) are certain to be installed.

Combination R-3 Reproducer and 2-stage Power Amplifier $90.00.

R-2 Magnavox Reproducer with 18-inch horn: the utmost in amplifying power. $60.00.

R-3 Magnavox Reproducer with 14-inch horn - - - - - $35.00.

Model C Magnavox Power Amplifier
AC-2-C **2-stage - - $55.00.**
AC-3-C **3-stage - - 75.00.**

Magnavox Products can be had of good dealers everywhere. Write for booklet.

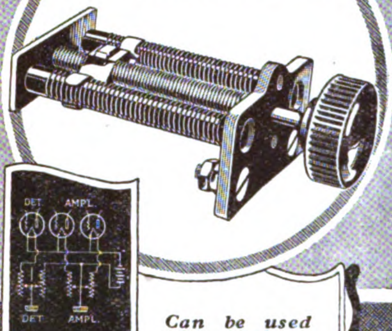
The Magnavox Co., Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

No Radio Receiving Set is complete without them

The Autostat

A Super Radio Rheostat



Can be used with 6-volt or WD 11 detector tubes, two amplifying bulbs or one 5-Watt power tube.

The difference between a jumbled mass of signals coming from everywhere and the "sharply-tuned" concerts received clearly and distinctly from far-away stations depends largely upon the careful adjustment of your detector filament current.

Heretofore, sharp tuning has only been partially obtained thru skillful "hair-breadth" manipulations of the filament rheostat. But with

The Autostat

A Super Radio Rheostat

these much-sought-for results can be secured by anyone. Just "twirl the knob"—a full turn produces a finer adjustment than a "hair's-breadth" turn on any other.

Economical — neat — small — compact. No carbon to break or change resistance. Unqualifiedly guaranteed. Popularly priced—$1.35.

*If the **Best** is none too good for the set you are building or have bought, see the Autostat at any good radio or electrical dealer **Today**. Or write direct for Free Bulletin which shows why the Autostat is radio's **Best** rheostat.*

DEALERS — JOBBERS
Write or wire for Radio's most attractive merchandising proposition.

THE AUTOMATIC
ELECTRICAL DEVICES CO.
132 WEST THIRD ST.
CINCINNATI, OHIO

Builders of Precision
Rheostats since 1914

CHARGE YOUR RADIO BATTERY at HOME for a NICKEL

PATENTED ARMATURE
The HOMCHARGER'S only moving and wearing part, replaceable after thousands of hours' use for $1.00. Tungsten contacts now used exclusively. Will not stick, corrode or wear excessively.

Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery OVER NIGHT for a nickel without removing it from your living room. Operates silently—charging rate governed automatically. No muss—no trouble—no dirt—requires no watching.

The HOMCHARGER is the ONLY battery charger combining all of these necessary features. SELF-POLARIZING—FIVE to EIGHT-AMPERE charging rate—UNDERWRITERS' APPROVAL—beautifully finished in mahogany and old gold—UNQUALIFIEDLY GUARANTEED. Over 100,000 now in use.

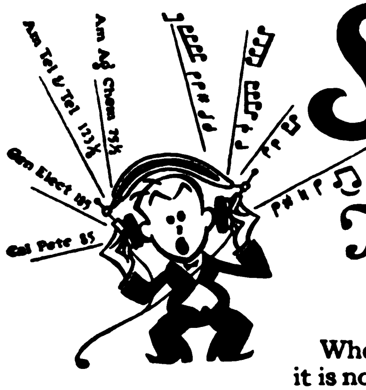
The minute you buy a radio set you need a Homcharger—get it then. All good radio and electrical dealers sell it complete with ammeter, etc., for $18.50. $25.00 in Canada.

Write for FREE circular showing why the HOMCHARGER is the BEST battery charger at any price.

MOTORISTS — THE HOMCHARGER will also charge your AUTO Battery.

THE AUTOMATIC
ELECTRICAL DEVICES CO.
132 WEST THIRD ST.
CINCINNATI, OHIO

Largest Manufacturers of
Vibrating Rectifiers in the World



Soprano Solos *by* The Stock Exchange

When you try to tune in with a single circuit receiver, it is not surprising that songs should suddenly turn into market quotations and bedtime stories into weather reports.

For with several hundred powerful broadcasting stations all operating on one narrow wave band, it takes real selectivity and sensitivity to get a satisfactory radio programme.

Get a Paragon three-circuit receiver. Then you will have the pleasure and satisfaction of obtaining the station you want when you want it. Clear, complete programmes without interruption or disturbance.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

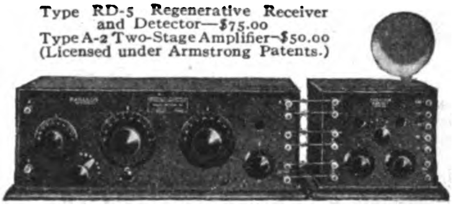
An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

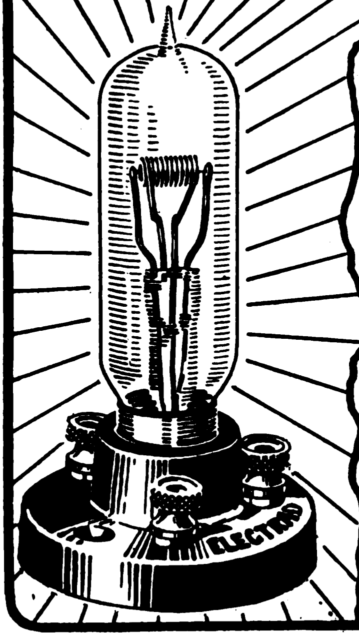
***Also Manufacturers of* PARAGON**

Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers



Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)

DRY CELL TUBE $2.00!



ELECTRAD DIODE

RADIO SENSATION OF 1923

The Electrad Diode has proven to be the biggest little thing in radio. Operating from two dry cells and requiring but a very small fraction of an ampere with no "B" Battery, it has taken its place as the most economical device of its kind in the world. The Diode has no grid, therefore it can produce no howling. As a two-element tube, it stands unmatched in sensitivity, quiet operation and long, serviceable life.

The Diode is NOT a substitute for a crystal. Rather, it is a new device, so inexpensive, so reliable and so perfect in operation that its use in place of a crystal is a matter of common sense. In clarity of tone and sweetness of reproduction, it is the crystal's only rival, yet it is far more sensitive, enabling its user to bring in stations that lie safely beyond the range of crystal receivers.

The Cost of the Diode is small, the results surprising. NO RADIO FAN CAN AFFORD TO OPERATE A CRYSTAL SET WITH THE DIODE AVAILABLE. Can be used with amplifiers. SOCKET FOR DIODE, 50c.

Sold by All Reliable Dealers. Manufactured Only by

The Electrad Corp. of America
428-30 Broadway, New York.

WHY METRO HEADPHONES ARE SUPERIOR

ACTUATING COIL CORES

Metro Headphones faithfully reproduce every sound variation so that reception is always clear and natural. The magnetic current which operates the diaphragm is transmitted by the actuating coils through the soft Armco Iron Cores, which allow a ready change of magnetic strength. It is this remarkable ability of the actuating coil cores to react faithfully to every magnet impulse that helps to produce Metro sensitivity. A small detail but perfection is made up of such details. Insist upon **Metro Headphones** because you can be sure that every detail is as it should be.

$6.00

Little Giant Receiving Set	*Metro Wave Selector*
A surprisingly compact set. Simplest tuning device. Complete with Metro Headphones **$14.00**	Makes any set highly selective. Completely separates 360 from 400 meters.......... **$7.50**

METRO ELECTRICAL CO., Inc.
Manufacturers of Metropolitan Radio Products
69 Goble Street Newark, New Jersey

Exide

BATTERIES

Uniform current cuts out the noise

EVERY radio amateur knows how disastrous battery noises are to clear receiving. You can avoid this annoying interference by getting the battery that insures a steady flow of filament current. That battery is the Exide Radio Battery.

This specially designed radio battery does its work uncomplainingly, and never requires much attention. The rasping, snarling noises often caused by fluctuating current in ordinary batteries do not exist in the Exide Battery. It delivers uniform filament current for every type of vacuum tube. You can count on the Exide for dependable, long-lasting service.

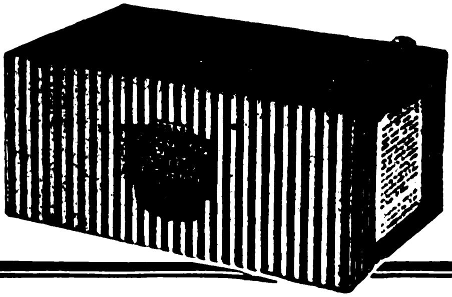
Exide Batteries are used in a majority of the government and commercial wireless stations and in every industry where a battery's response to the call of duty must not fail.

Any dealer in radio equipment will sell you an Exide Radio Battery, or you can get one at the nearest Exide Service Station.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia, Pa.

Service Stations Everywhere

Branches in Seventeen Cities



BURGESS
RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.

BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

BURGESS BATTERY COMPANY

Engineers Manufacturers
Dry Batteries
Flashlight Radio Ignition Telephone
General Sales Office:
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Madison, Wisconsin
Branches:
New York Boston Washington St. Paul
Kansas City New Orleans

In Canada: **BURGESS BATTERIES, Ltd.**
Winnipeg Toronto Montreal

BURGESS
RADIO BATTERIES
"ASK ANY RADIO ENGINEER"

Just Out

Over 20,000 Call Letters and Map-size 2x3 ft

Indispensable to every radio owner. Contains up-to-date list of over 20,000 Amateur, Commercial, Army, Navy, Transoceanic High Powered, and Broadcasting Stations in the United States and Canada; International Morse Code and Convention Signals; the construction and operation of the Reinartz Tuner, Detector, and one-stage Amplifier; also an abundance of other useful information.

Included with the book is a splendid two-color map of the United States and Canada, 2x3 ft., showing radio district boundaries, standard time lines, geographical location of broadcasting stations, etc.

Buy the Book with the Blue Cover

The greatest dollar value on the radio market. At your dealers or direct by mail. Use check or money order. Do not send stamps.

Dealers: write for proposition

Radio Directory and Publishing Co.
45-J Vesey Street New York City

The Receiver of Tomorrow

The Symphony

Tomorrow in Radio means a wider and more useful as well as more entertaining broadcasting. Therefore, to the purchasers of receiving sets, the design, the material, the workmanship, the circuit and the assembly, all play an important part in the quality of reception, and distance heard.

The placing of a Symphony in your home is a permanent investment that will win your instant approval, and occupy a prominent place among your most cherished possessions.

The clear reception and unusual volume are the results of the high grade units, the fine workmanship, the most efficient circuit, and the correct assembly. The improved circuit used in the Symphony combined with the accuracy of its construction, has increased the selectivity to a marked degree.

The range of the Symphony Receiver is unlimited. Recently, in Chicago, Havana, Cuba, was tuned in not only on a head set but heard plainly on a loud speaker.

The Symphony Receivers are made in two types—Three and Two stages of audio frequency amplification.

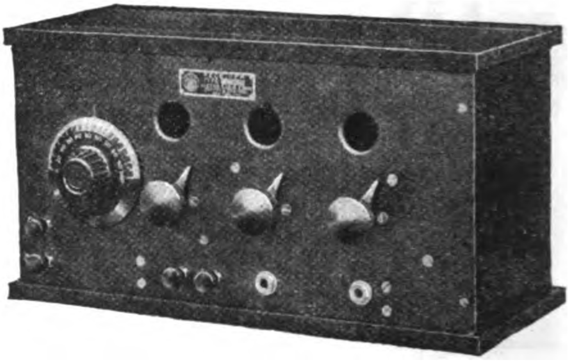
If your dealer cannot furnish information on the Symphony, write for illustrated catalog, giving us his name.

JONES RADIO COMPANY
Lytton Building, Chicago

The Symphony is manufactured under the U. S. Patent No. 1113149, Armstrong Regenerative Circuit

All parts used in the Symphony are built and guaranteed by the Kellogg Switchboard & Supply Company for twenty-five years manufacturers of complete telephone equipment

"Victor Senior"



A New Tuner, Detector and Two-Stage Amplifier

The ideal set for your vacation—compact, easy to move.

A very simple set to operate as there is only one master dial on which all tuning is done.

Distance is one of its many outstanding features.

LIBERAL DISCOUNTS TO JOBBERS and DEALERS

Catalog issued on request

VICTOR RADIO CORPORATION

795-799 East 135th Street **New York City**

The Most Wonderful Radio Loud Speaker in the World

$28.50

MAHOGANY FINISH

PHANTOM VIEW SHOWING

The Adjustable Air Gap

consists of an adjusting dial mounted in front of the cabinet, by means of which the distance between the magnetic poles and the diaphragm may be increased or decreased, thus varying the pull of the magnet on the diaphragm and permitting tuning up in complete harmony under all varying conditions of reception.

The DICTOGRAND

with the Adjustable Air Gap

Overcomes the defects common to all other radio loud speakers—the harsh jarring sounds, the noises and overtones.

Designed to operate on any vacuum tube receiving set, giving maximum results when two stages of amplification or more are used. Requires no extra batteries. You simply plug in—and listen.

The DICTOGRAND RADIO LOUD SPEAKER, like all Dictograph products, is guaranteed for a period of one year against all electrical or mechanical defects.

ASK YOUR DEALER TO DEMONSTRATE IT

The unusual demand upon our facilities has not enabled us to complete our distribution. If your dealer has not yet received his stock of **DICTOGRAND Radio Loud Speakers**, send to us direct.

Makers of the Famous Dictograph Radio Head Sets

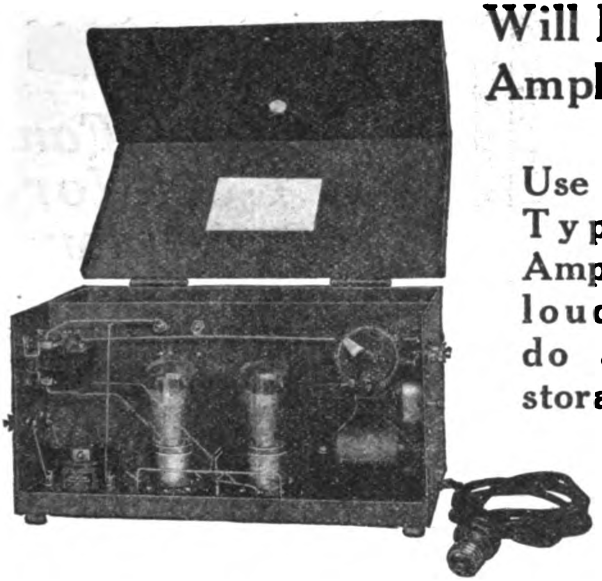
DICTOGRAPH PRODUCTS CORPORATION

Dept. P. R., 220 West 42nd Street, New York City

Branches in All Principal Cities

Dealers: Order through your jobber; or send to us direct for names of authorized distributors.

A Lamp Socket—Not a Storage Battery—Will Run Your Power Amplifier—



Use a General Radio Type 272 Power Amplifier with your loud speaker and do away with the storage battery

General Radio Company's type 272 Power Amplifier is a complete, self-contained unit and may be used with any type of receiving set—crystal or tube. No storage battery is needed if the detector is either a WD-11 tube or a crystal.

Simply screw the plug in a lamp socket on any 110 Volt A. C. lighting circuit. An On and Off switch, mounted at the side of the handsome metal case, permits a permanent connection being made with any convenient outlet, if desired. Two stages of amplification are provided, each stage using a five watt tube.

When a General Radio type 272 Power Amplifier is received from the dealer, all that is necessary is to slip one—or two—45 Volt plate batteries and one 4 Volt grid biasing battery into the compartment provided within the cabinet. Then turn on the tube, adjust the filament rheostat and grid biasing battery, close the hinged cover of the cabinet and for six months enjoy the most complete and satisfactory amplification you have ever known.

Price, exclusive of vacuum tubes and batteries—$40.00

Ask for a copy of Bulletin 912U

GENERAL RADIO COMPANY

MANUFACTURERS OF

RADIO AND ELECTRICAL LABORATORY APPARATUS

MASSACHUSETTS AVENUE AND WINDSOR STREET
CAMBRIDGE 39 MASSACHUSETTS

Standardize on General Radio Equipment Throughout

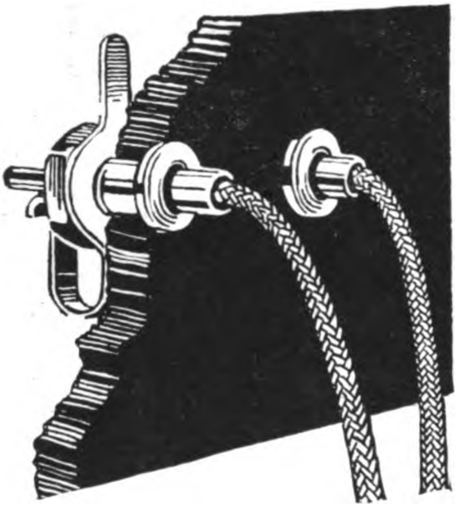
5164

Read Why You Should Use

UNION-RADIO PHONE TIP JACKS

(*Pat. Applied For*)

25c A PAIR



Here's the Radio device that you have been waiting for. These Phone Tip Jacks assure quick connection and a positive contact. They replace unsatisfactory binding posts. Soldering lug incorporated but use optional.

Accommodate any standard round phone tip and several sizes of bare wire. Great for W D 11 connections and coil mountings. Save buying expensive telephone plugs and jacks. They live up to the Union Radio Standard of Quality. Guaranteed to satisfy. Only 25c a pair.

FOR ASSURED RESULTS

you should "try out" Union Radio Tip Jacks, Variable Condensers, Rheostats, Vacuum Tube Sockets, Condensite Dials.

Union Radio Apparatus and Accessories are sold by most good dealers. If you can't obtain them from your local store mail your order to us. Write for a copy of our Catalogue A Radio Apparatus.

Wholesalers and Retailers:

Write for our liberal proposition. Dealers' Catalogue A and Price List, also samples, sent on request.

UNION-RADIO-CORPORATION
200-MT. PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE — 116-WEST-32nd-STREET.

Now Radio Fans Can Get More For Their Money

THE NEW "A" BATTERY

RADIO ACE BATTERY

For operating WD-11 Tubes using 1½ volts

There Is No Other Battery Like This Because:

It has a voltage of 1.60 per cell which is .10 higher than the ordinary dry cell and, inasmuch as the W D-11 tubes cannot be operated after the dry battery has dropped in voltage to 1.1, the ACE gives much longer service.

It has a specially constructed air pocket under the sealing compound to permit escaping gases to expand, thus preventing blown seals.

It is equipped with locknut terminals to assure absolutely leak-proof connections. Conductivity of current complete.

It sells for less.

Types	*Cells*	*Volts**
No. 61	1 cell	1½ volts
No. 62	2 cells	1½ volts
No. 63	3 cells	1½ volts
No. 64	4 cells	1½ volts

**Note: Because it is common to refer to dry battery voltage in terms of 1½ volts, each type is specified in these units, despite the extra voltage available.*

The Cells are of Special Radio Construction and Give Many Times the Combined Life Service of Single Cells, Used Individually one after the Other.

DEALERS: Here is a dry battery proposition that offers you more turnover and greater profit. Write at once. Dept. S.

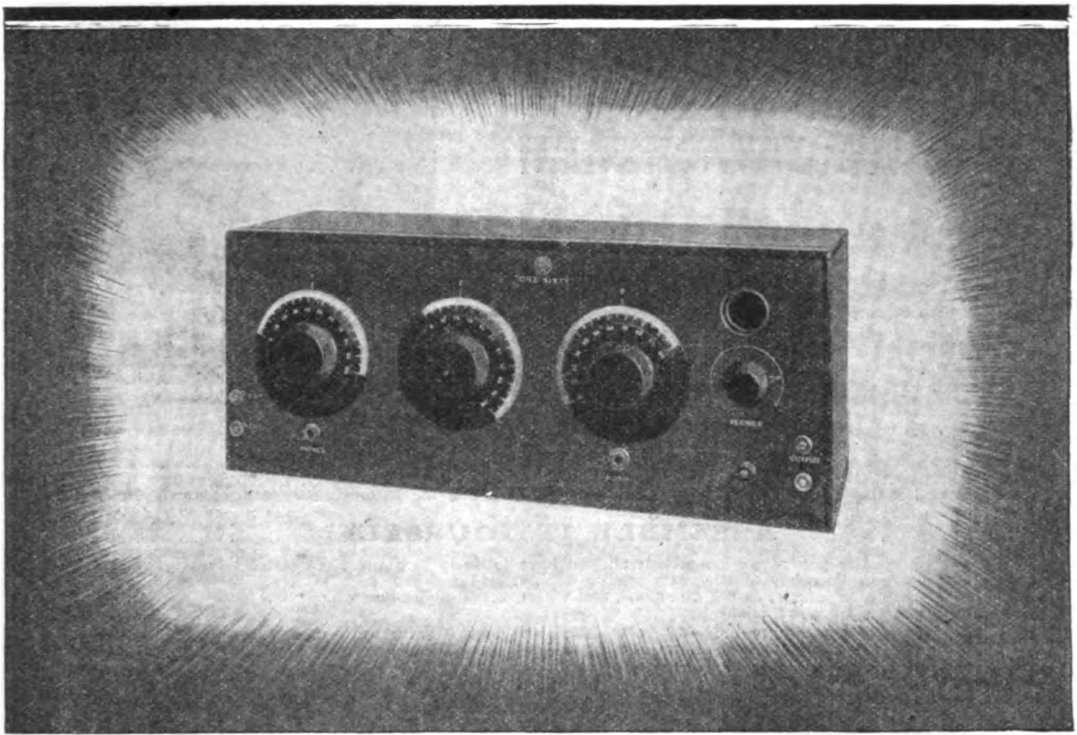
THE CARBON PRODUCTS CO.
Lancaster, Ohio

Here is another remarkable battery for general ignition and camp lighting: "The Reliable Ace in a Metal Case."

THE NEW HOT SPARK IGNITION BATTERY

Metal case—non-short circuitable—4 cells 6 volts—long life.

DEALERS: Many of your radio customers are ignition customers.



The famous **FADA "ONE SIXTY"** *with the* **NEUTRODYNE** *circuit*

Neutrodyne

is the name given to a marvelous new radio receiver circuit invented by Professor L. A. Hazeltine, of Stevens Institute of Technology, Hoboken, N. J., and used in the FADA "ONE-SIXTY" receiver.

Only four vacuum tubes are used. The selectivity is remarkable and yet the dials can be easily adjusted to receive distant stations.

The FADA "ONE-SIXTY" will receive broadcasted concerts from the Atlantic to the Pacific and with loud speaker intensity.

Denver, Colo., San Antonio, Tex., Havana, Cuba, and Los Angeles, Calif., are some of the far distant stations listened to from New York City, using only a small indoor antenna.

The FADA "ONE-SIXTY" is the ideal receiver—the cost $120.00

F. A. D. ANDREA, INC., 1581-D JEROME AVE., N. Y. CITY

The FADA "ONE SIXTY"

—WITH THE NEUTRODYNE CIRCUIT—

A "B" Battery Built for Radio By Radio Experts

HIGH POWER—WITH A STEADY EVEN FREE FROM NOISE FLOW OF ELECTRICITY

Not a cricking sound—just a pure tone of the radio message. The SIDBENEL STORAGE "B" BATTERY, different than others, is made in a one-piece hard-rubber container. The ten necessary cells are molded into it—making the battery most sound and rigid. The complete battery measures only two and one-half inches wide, three inches high, four and seven-eighths inches long, and weighs less than three pounds—yet it has as much power as batteries three times the size and price.

SPECIAL PATENTED PLATES CHARGED AND FORMED BEFORE LEAVING THE FACTORY ARE USED

They will give an immediate discharge of FIFTEEN AMPERE and a voltage of twenty-two and one-half variable from two volts up. A single charge will give approximately six months' service; however, should it become partly discharged at any time, just connect it to your charger, lamp-socket or lighting generator, and within a few hours your SIDBENEL STORAGE "B" BATTERY will be recharged to its full capacity, costing you less than one-half a cent, and saving you the price of a new battery. Each time the battery becomes discharged you simply recharge it.

ASSEMBLE IT YOURSELF

The battery is shipped to you partly assembled; all you have to do is to connect the plates together, which takes less than ten minutes. Any boy of ten years can do it. Instructions with each battery. Connect to any lamp-socket or farm-lighting generator, as per directions, and within a few hours you will have a battery that is superior to any on the market. Give it a trial.

One single unit—22 volts—variable from 2 volts up.....$4.25

Two single units	**$8.10**	**Four single units**	**15.25**	**Six single units**	**$22.25**
Three " "	**11.75**	**Five " "**	**18.50**	**Seven " "**	**25.75**

ASSEMBLED PER UNIT $4.65

Send for Free Catalog

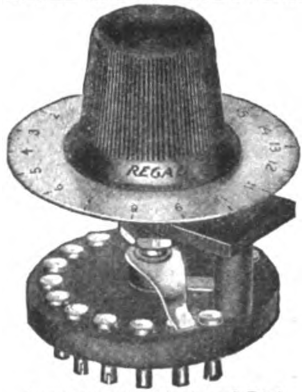
Sidbenel

RADIO EQUIPMENT MFG. CO.

Dept. P. R.

25 Mt. Eden Ave. New York City

"REGAL" INDUCTANCE SWITCH



Complete with Knob and Dial
$2.00

Two Biggest Hits In Radio

Regal Inductance Switch

Does away with all drilling of holes in panel. Does away with all switch points. Requires but one hole to attach to panel. Complete 15 point switch in one unit.

Regal Rheostat

A scientific precision instrument. Full exposed resistance wire. More sensitive than a vernier. 6 Ohms resistance —2.2 Amperes.

Condensers, Power Rheostats, Potentiometers, Vario-Couplers, Jacks, Knobs, Dials, etc. Send for our new catalog No. 27.

(If your dealer does not carry Regal Radio Products write us direct)

"REGAL" RHEOSTAT

Complete with new Regal Knob
$1.00

THE AMERICAN SPECIALTY COMPANY BRIDGEPORT, CONN.

The PACENT 50c.

New UNIVERSAL PLUG

Number Forty

The quality of this plug and its low price enable you to enjoy satisfactory plug connections on every piece of your radio equipment. Look for the PACENT Trade Mark and ask for PACENT New Universal Plug No. 40.

Materials that last
Simple, Sturdy Construction
Permanent Biting Contact
Perfect Insulation

The makers of the FIRST Radio Plug now offer the first Quality plug at a popular price. This plug meets perfectly every radio requirement.

Don't Improvise—"Pacentize"
Write for Descriptive Bulletin P-5

PACENT ELECTRIC COMPANY, Inc.

Executive Offices
22 Park Place
New York, N. Y.

Sales Offices
Chicago Washington, D. C.
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Members Radio Section, Associated Mfrs. of Electrical Supplies
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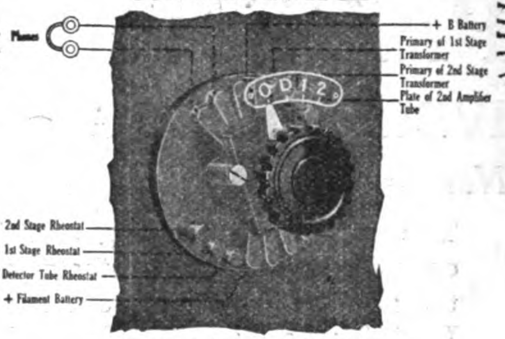
Pacent
RADIO ESSENTIALS

A-C DAYTON

FIL-FONE

CONTROL SWITCH

A-C DAYTON



Dispenses with
Jacks
Plugs

Saves
Wire
Time
Money

Protected by Patents Pending
PRICE $3.00

The **Fil-Fone Switch** is the latest addition to our remarkably complete line of Radio Products. Designed for convenience and elimination of surplus parts. Gives the operator perfect control of his tubes without noise or inconvenience of plugging in phones from one stage to another.

The **Fil-Fone Switch** automatically lights the filaments and connects the "B" Battery and telephones to either Detector, first stage of amplification or second stage of amplification as desired, with a positive and progressive operation. It has an "OFF" position which disconnects the filament battery, "B" battery and phones from the set.

This method of filament control is sure to be universally adopted in set building because of its simplicity, convenience and saving of expense. Sold ready for mounting, with complete wiring diagram.

Send for Free Descriptive Circular, F. F. S. No. 1
(Complete catalog of Radio Parts with useful Radio information sent on receipt of six cents in stamps for mailing.)

The A-C Electrical Manufacturing Co. - Dayton, Ohio
Makers of Electrical Devices for Over 20 Years

A SUMMER NECESSITY

TT
IMMONS
ALKER

DURING sultry summer nights no one will want to listen in with a pair of hot, restraining and cumbersome earphones pressing against their head.

BY attaching a TIMMONS TALKER to your set you can let everyone of your party "Enjoy Radio the Unselfish Way."

THE TIMMONS TALKER

has adjustable amplification so you can always secure just the right tone value for any audience listening to your set. It is self-contained in a handsome mahogany cabinet. Needs no extra batteries.

WE urge you to buy your TIMMONS TALKER before the summer demand begins. Sold by all worth-while dealers.

J. S. TIMMONS
337 East Tulpehocken Street, Philadelphia, Pa.

LIKE THE POWERFUL TELESCOPE that makes us neighbors to the stars, Mu-Rad Receivers annihilate distance with delightful ease. Honolulu is as near to St. Louis by Mu-Rad reception as New York.

So marvelously sensitive that it requires only a 2-foot loop aerial. Distinct reproduction with hair breadth selectivity, and yet easy for even a novice to operate. Conservatively guaranteed for 1000 miles.

Write for literature

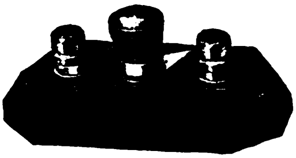
The New Star in the Radio World

Mu-Rad Laboratories, Inc.

809 Fifth Ave. Asbury Park, New Jersey

FRESHMAN PRODUCTS—ACCURATE AND DEPENDABLE

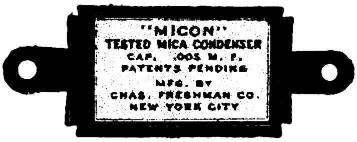
VARIABLE RESISTANCE LEAK



With .00025 mfd.
MICON Condenser
Combined **$1** Without Condenser **75c**

Unbroken range—Zero to 5 Megohms—Clarifies signals, lowers filament current, increases battery life, eliminates hissing.

"MICON" Tested Mica CONDENSERS



Size	Price
.00025	$0.35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.006	1.00
.01	1.50

Assure absolute noiselessness—clarity of tone—accuracy—constant fixed capacity.

Freshman products are standard and can be used successfully with practically any circuit.

ANTENELLA

No antenna or aerial needed. Eliminates all the inconveniences in radio, operates from any light socket. Price only $2.00.

$2

At your dealer's—otherwise send purchase price and you will be supplied postpaid.

CHAS. FRESHMAN CO., Inc.
106 SEVENTH AVENUE NEW YORK

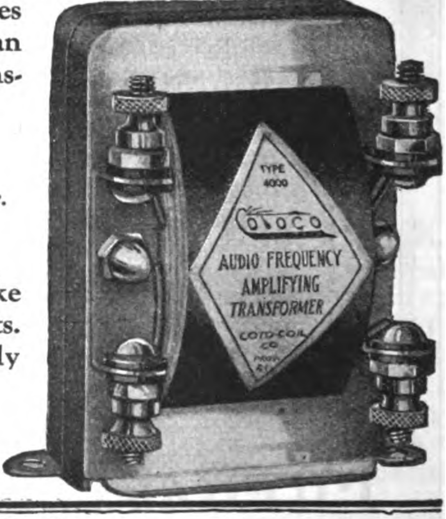
Just Consider

—the essential features necessary to make an audio frequency transformer a good one—

1. *High Amplification.*
2. *Minimum Distortion.*
3. *Low Interstage Linkage.*
4. *Convenient Mounting.*
5. *Compactness.*

Cotoco transformers make these ideal features facts. And the finish will surely please you.

"Built First to Last"
$5.00
At Your Dealer's



COTO-COIL CO. PROVIDENCE

Pacific Coast Branch, 329 Union League Bldg., Los Angeles

MUSIC MASTER
Radio
AMPLIFIER

Rich Resonance that Only WOOD Can Give

THEY call MUSIC MASTER the "Stradivarius Among Amplifiers." For its horn is WOOD, with that pure, mellow-sweet tonal quality of the human voice that wood alone can simulate. (Phonograph experts proved the principle before radio.)

A powerful amplifying unit in the art-metal base of MUSIC MASTER sends sounds up through a cast-aluminum "gooseneck"—cast aluminum, so it won't vibrate. This conveys true tones to the wooden horn, where they are beautifully enriched, humanized and given to the audience as they are actually sung, played or spoken.

There is only one MUSIC MASTER. Get it and you won't regret it! Hundreds of orders are pouring in daily. Demand actually exceeds supply, so get your order in NOW! Comes complete, ready to attach in place of head 'phones. No extras to buy. Hear MUSIC MASTER at your dealer's today. COMPARE it with any other amplifier, regardless of price! Literature on request.

Ask about the GERACO Phonograph Attachment which makes an efficient radio loud-speaker of your Victrola or Columbia. Only $10.

14-inch Amplifier complete, $30

21-inch Amplifier complete, $35

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus
CHICAGO PHILADELPHIA PITTSBURGH
624-628 Market St.

JOBBERS—
DEALERS
A MUSIC MASTER will be sent to you with full privilege of return.

GERACO
PROVEN RADIO PRODUCTS

Write for full description of the GERACO line, and prices.

Built on Honor

The Acid Test

Gently tap one terminal of Ambassador Phones on a cent, or your tongue, and a faint "click" will be heard.

(Other phones will not stand this test.)

Type A B	Prices
2000 Ohms	$5.00
3000 Ohms	5.50
4000 Ohms	7.00
5000 Ohms	8.00

Individuals may order by mail and we will gladly ship C. O. D.

Ambassador
RADIO-PHONES
The PHONES THAT STAND THE ACID TEST
Finest in the World at the Price

$1000 REWARD

to anyone showing proof of our refusing to stand back of our guarantee on Ambassador Phones.

Specifications

Adjustable (navy type) head-bands, comfortable and strong, beautifully nickeled.

Case of heavy stamped aluminum.

Cap of finest hard rubber and unbreakable.

Coils wound with highest grade enameled copper wire.

Magnets of Chrome steel will retain their power for years. 5 foot cords—best grade tinsel.

Weight, 12 ounces. Shipping Weight, 1 lb.

Our Guarantee

If you are in any way dissatisfied with our product, return same within thirty days and your money will be refunded on request

Special Discounts to Dealers

TOWER MANUFACTURING CO. - 114 Station St., Brookline, Mass.

"ALL AMERICAN" Sets World Record for Long Distance Radiophone Receiving

When WDAP CHICAGO Talked to S. S. BERENGARIA

The Signals Were Amplified Aboard-Ship Thru **"ALL-AMERICAN" AMPLIFYING TRANSFORMERS**

WDAP, The Drake Hotel, Chicago, made history in radio, by talking day-by-day with the S. S. Berengaria, enroute New York to France. Miss Florence McDonald, a passenger, installed Standard Zenith Receiving Set in the steamship cabin, and, every evening during the voyage, WDAP talked to her and other passengers from Chicago, their voices coming clear and strong with the personality easily recognizable.

The set used by Miss McDonald is one of the regular Zenith Sets, manufactured by the Chicago Radio Laboratory, Chicago, Ill. It contained, as standard equipment.

"ALL-AMERICAN AMPLIFYING TRANSFORMERS

R-10—Radio Frequency (150-500 meters)	$4.50	R-13—Audio Frequency (Ratio 10 to 1)	$4.75
R-12—Audio Frequency (Ratio 3 to 1)	4.50	R-21—Audio Frequency (Ratio 5 to 1)	4.75

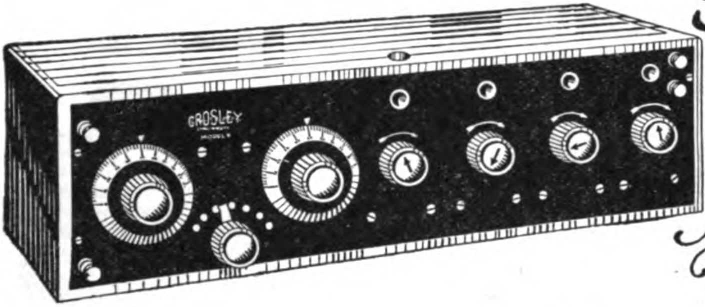
Send for our circular — "Cascading of Amplification". Also our Free Book of Radio Hookups.

ALL-AMERICAN **RAULAND MFG. CO.** ALL-AMERICAN

200 N. Jefferson St., Chicago, Ill.

CROSLEY *Model* X

$55



A 4 tube Radio Frequency Set

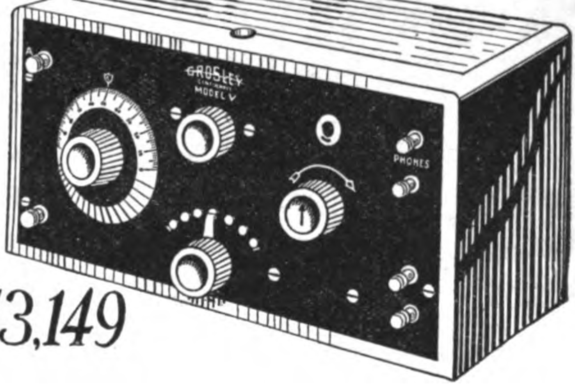
THE HIT OF THE RADIO WORLD
FOR SALE by Good Dealers Everywhere
Catalog on request to Dealer or Consumer

CROSLEY MANUFACTURING COMPANY
516 ALFRED STREET CINCINNATI, OHIO

CROSLEY *Model* Vc

$20

Regenerative Receiver Set



Licensed under Armstrong U.S. Patent No. 1,113,149

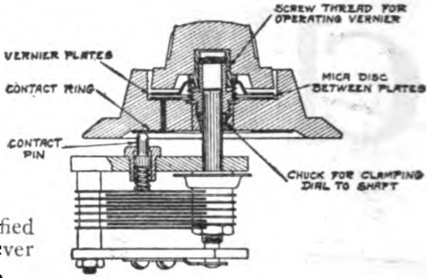
The trade name "Crosley" is used by permission of the Crosley Manufacturing Company.
Write for FREE Catalog!

THE PRECISION EQUIPMENT CO.
Powel Crosley Jr. President
516 GILBERT AVENUE CINCINNATI, OHIO

NEW "UNITED" VERNIER

A MIRACLE-WORKER

In Fine, Selective Tuning.
Operates on a New Principle.


SCREW THREAD FOR OPERATING VERNIER
VERNIER PLATES
CONTACT RING
MICA DISC BETWEEN PLATES
CONTACT PIN
CHUCK FOR CLAMPING DIAL TO SHAFT

Will bring in the elusive stations that have thus far defied you, by giving at least *twice* as fine a tuning as has ever been possible with the best condensers thus far developed.

Can be attached to any plate condenser, by drilling one hole in top plate.

Price, each, postpaid, $2.50

"UNITED" VARIABLE CONDENSERS WITH NEW VERNIER

43-plate—each $6.50
23-plate—each $6.00
11-plate—each $5.50

"UNITED" TRANSFORMER

Audio Frequency. Amplifies detected signals so they come in clear and strong, for either headphone or loudspeaker reception.

Each $4.50

Send for Catalog of United Products

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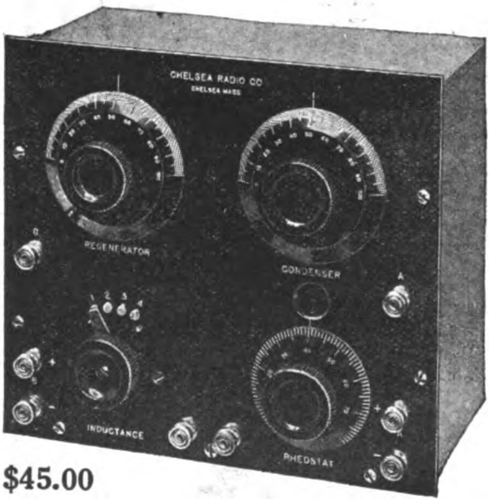


$45.00

CHELSEA REGENERATIVE RECEIVER

A Real Broadcast Receiver

Range 150 to 800 meters

- ¶ Perfection in design
- ¶ Pleasing appearance
- ¶ Simple and accurate tuning

**A Chelsea product, embodying Chelsea equipment throughout.
Licensed under Armstrong U. S. Pat. No. 1113149. For amateur use only.**

Write for our new No. 7 Catalogue

CHELSEA RADIO COMPANY

177 Spruce Street **Chelsea, Mass.**

The Loud-Speaker With the Natural Tone

The Bristol "Audiophone" will bring into your presence the actual "tonal personality" of the speaker, the singer or the player. You will hear them as they are—not disguised by mechanical distortion. The "Audiophone" is a true sound reproducer, retaining all the fine gradations of tone quality, volume and feeling which distinguish the original performance of the artist. You forget the instrument, in your enjoyment of the entertainment it brings to all your household and the guests who may join you.

BRISTOL

TRADE MARK

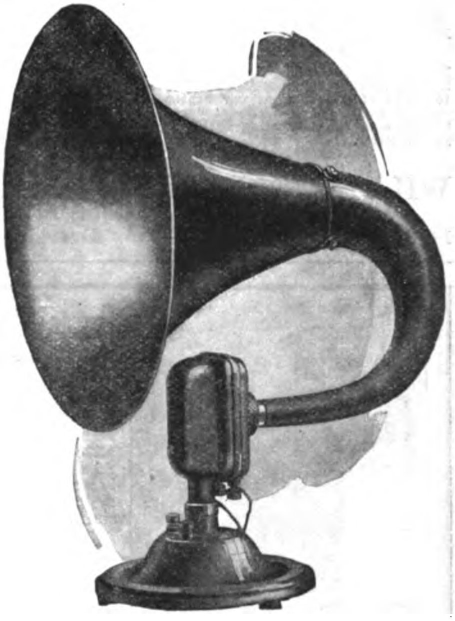
AUDIOPHONE

Reg. U. S. Pat. Office

LOUD-SPEAKER

MOST SIMPLE AND EFFICIENT

Construction Covered by Basic Patents



Years of research in sound reproduction, in the laboratories of an established engineering concern, have made the "Audiophone" what it is—have given it its round, full tone, its ample carrying power, its distinctive freedom from blurring and distortion. It needs no separate storage battery for magnetizing current, and can be used with any two or three stage power amplifiers.

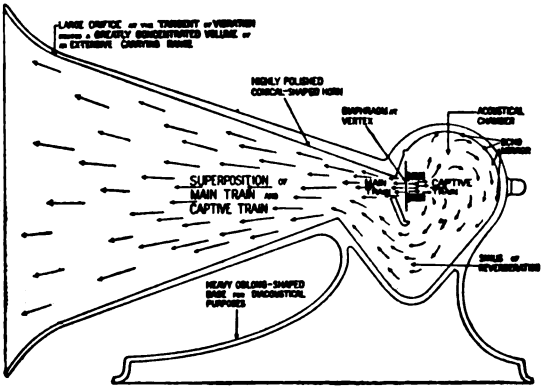
"AUDIOPHONE SR." Complete, 15-inch bell, $32.50
"AUDIOPHONE JR." Complete, 13-inch bell, $22.50

A new Bristol single stage power amplifier for use with the usual two stage amplifier can be furnished, which will greatly increase the range of the Audiophone where desirable. Price $25.00.

Ask your dealer to demonstrate the "Audiophone." If he hasn't it, write us—we will see that you are supplied.

THE BRISTOL COMPANY

WATERBURY CONNECTICUT


LARGE ORIFICE AT THE TANGENT OF VIBRATION [illegible] A GREATLY CONCENTRATED VOLUME OF AN EXTENSIVE CARRYING RANGE
HIGHLY POLISHED CONICAL-SHAPED HORN
DIAPHRAGM AT VERTEX
ACOUSTICAL CHAMBER
ECHO MIRROR
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
MAIN TRAIN
CAPTIVE TRAIN
SINUS OF REVERBERATION
HEAVY OBLONG-SHAPED BASE FOR DIACOUSTICAL PURPOSES

ECHO-TONE

GIVES FIBRE NEEDLE TONE TO THE RADIO PHONE

An acoustical chamber, an echo mirror and a sinus of reverberation, has made Echo Tone more than a *horn,* it is an acoustical instrument.

Convince Yourself of Its Faithful Service

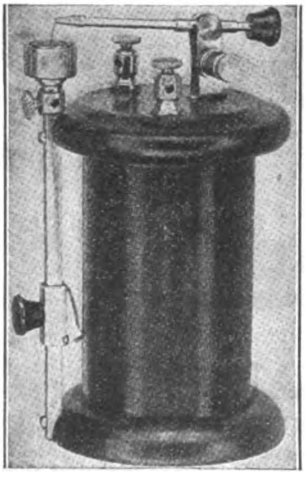
If there is no Echo-Tone dealer near you, send a check or money order for $35.00 direct to us. Upon receipt of the money, we will immediately express an Echo-Tone to you. Try it out on your own set. If it does not prove entirely satisfactory to yourself and family, replace it in its wooden box and give it to the expressman consigned to us. Simply mail us the express receipt, not even necessary to write us your reasons for returning it. As soon as we receive the receipt, we will refund your money, without even waiting until we receive the instrument. Remember, we pay express charges both ways, making it just as convenient as though you were buying in the same city.

QUALIFIED DEALERS WANTED

Introducing ECHO-TONE, thruout the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has been allotted to your district.

Retail Price, $35.00

WILLIAMS RADIO COMPANY
Radio Tone Specialists
1438 Washington Blvd. Detroit, Mich.



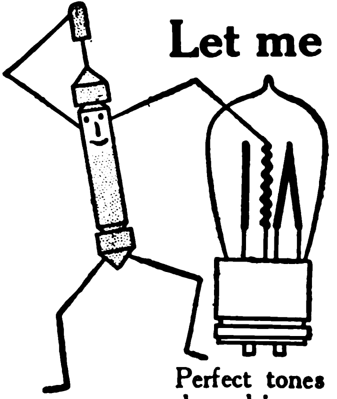
Crystal Set . . $2.50

The Ritter Grand Crystal Set will tune up to 600 meters and receive all concerts within 25 to 50 miles. It is made of the best materials, stands six inches high and has a 100% rating from the Technical Department of "Popular Radio."

Free circular on how to erect your aerial sent upon request. We invite jobbers' and dealers' inquiries.

RITTER RADIO CORPORATION
232 Canal Street
New York City

Let me *regulate* Your Grid Leakage



No. 201A—
Special, the only leak made for this size tube, 2 to 10 megohms

No. 101—
Up to 5 megohms

No. 100—Up to 100,000 ohms

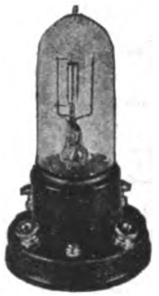
75c each

Perfect tones in the phones depend just as much on close grid leak regulation as on filament current control. That's why Mr. E. T. Flewelling recommends DURHAM Variables—the plunger permits exact regulation. Buy from your dealer.

Durham & Co., 1936 Market St., Philadelphia

DURHAM Variables High Resistance

It's the contact that counts



Na-ald W.D.11
No. 411

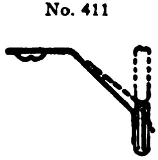
The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.

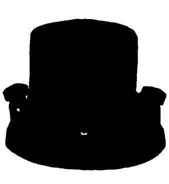
The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each

Send stamp for dial, small-space socket, condenser and R ¼ transformer circulars



ALDEN MANUFACTURING CO.
Formerly Alden-Napier Co.
Dept. C 52 Willow Street
Springfield, Mass.



Na-ald De Luxe
No. 400

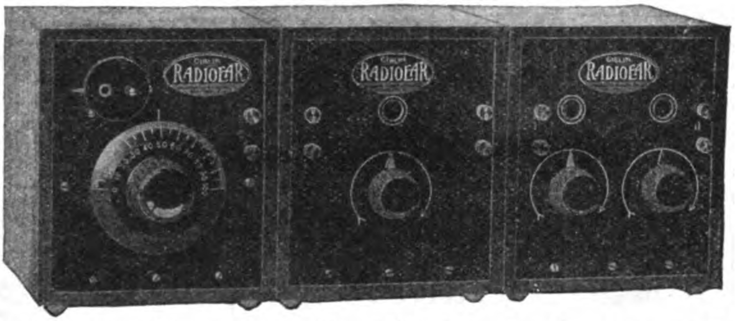
NA-ALD

Booklet with wiring design instructions for Hazeltine's Neutrodyne and the Flewelling Super-regenerative Circuits, and a number of standard circuits, packed with each socket.

GIBLIN

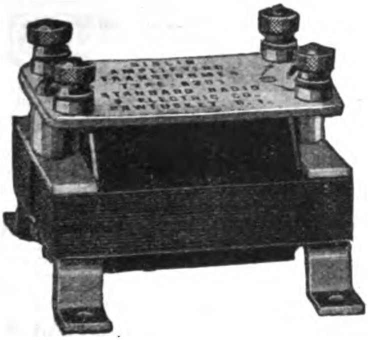
RADIO APPARATUS

Every product manufactured by us is the result of the inventive genius of Thomas P. Giblin. For years this master inventor has concentrated on the development of wireless telegraphy and telephony. The three leaders illustrated here are perfect in design and construction, and their performance is guaranteed.



The "RADIOEAR"
Vacuum Tube
Receiving Set

This set includes the new Giblin receiver, detector and two-stage amplifier. The single-control tuner is easily and quickly tuned with full efficiency on any wave length. Local and distant stations can be heard with perfect clearness. The amplifier secures maximum volume without distortion. For the average radio enthusiast, this set will do all that could possibly be desired. Price, $50.00.



Audio-frequency Amplifying Transformer

This transformer has won the approval of radio enthusiasts from coast to coast. It is designed for use with standard amplifying tubes, and gives maximum amplification without noise or distortion. May be placed in any position without pre-magnetic coupling and squealing. Price mounted, $4.50; unmounted, $3.50.

Radio-frequency Amplifying Transformer

Features: Simplicity of operation; elimination of static and interference; loop reception of signals made possible regardless of the distance of transmitting station; maximum amplification; maximum resistance without the use of iron; maximum coupling between primary and secondary winding; minimum of distributed capacity. Price $7.00.

If your dealer cannot supply you, order direct.

STANDARD RADIO & ELECTRIC CO.
PAWTUCKET, RHODE ISLAND

Announcing

THE NEW JENKINS VERNIER RHEOSTAT

CALLED THE UNITY VERNIER RHEOSTAT

An improvement on the Jenkins Rheostat, manufactured and sold by us heretofore.

The UNITY VERNIER RHEOSTAT has a BAKELITE base.

Genuine NICHROME RESISTANCE WIRE.

PATENTED adjustable screw fastens wire, thus eliminating all "loose wire" trouble.

PATENTED CUT OUT SWITCH with positive spring contact mounted directly in Rheostat, permits switching on or off with tuning unchanged.

PATENTED METHOD OF FASTENING resistance wire permits easy changing of wire to obtain a resistance suitable to any tube, or to replace if burnt out.

Suitable for use in the detector circuit of the four-circuit tuner.

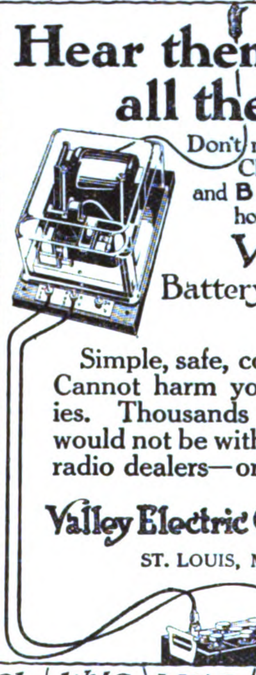
Price: $1.75. Add ten cents for postage. *Hear a set that uses one.*

UNITY MANUFACTURING COMPANY, 224-232 N. HALSTED ST., CHICAGO
CONTRACT MANUFACTURERS
DEALERS AND JOBBERS WRITE FOR SAMPLES

WWJ KDKA WSB KSD WOC

WHAS WOAL KYW NAA KFI WGM WLAG KHJ WHB

WGY CFCA WBAP KFKA WEAF WDAF WHAA WLAY



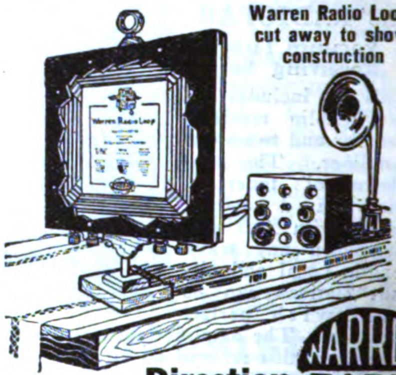
Hear them all, all the time

Don't miss a program
Charge your **A** and **B** Batteries at home with a
Valley
Battery Charger

Simple, safe, convenient. Cannot harm your batteries. Thousands of users would not be without it. At radio dealers—or write us.

Valley Electric Company
ST. LOUIS, MO.

WOI WMC WDAP KDYX PWX



Warren Radio Loop, cut away to show construction

WARREN RADIO LOOP

Direction Finding

A New Radio Pleasure

LOCATE ships at sea, trace amateur stations to their hiding places, direct your receiving in the full path of broadcasting stations.

THE type B2537 or type BL2520 Warren Radio Loop, the most compact, efficient, attractive loop aerial, is all you need. Our new Bulletin I-102 explains the fascinating art of direction finding and gives hookups.

A Type for Every Set—at the Best Dealers

Type-A-787 (300-700 meters) 6 inches square—non-directional	**$10**
Type-A-7236 (175-1000 meters) 6 inches square—non-directional	**$12**
Type-B-2537 (300-700 meters) 18 inches square—directional	**$20**
Type-BL-2520 (200-18,000 meters) with honeycomb coil. 18 inches square—directional	**$25**

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO. Dept. FF. **Asbury Park, N. J.**

WHY NOT HEAR 'EM ALL?

The UNIVERNIER will make any instrument on your radio set "vernier" in its operation. Your outfit will be at least 100% more selective than before, and enable you to pick out with precision, stations that were entirely missed by usual adjustment.

By turning the UNIVERNIER as you would an ordinary knob, the speed of your instrument shaft is reduced nearly one-twelfth. By pressing toward the panel against light spring tension the UNIVERNIER will function as an ordinary knob. The UNIVERNIER takes the place of the common knob or dial, and is easily installed in a few minutes on ordinary variable condensers, variometers, tickler coils, variocouplers, potentiometers, and rheostats. It is the *logical* way to obtain genuine vernier adjustment.

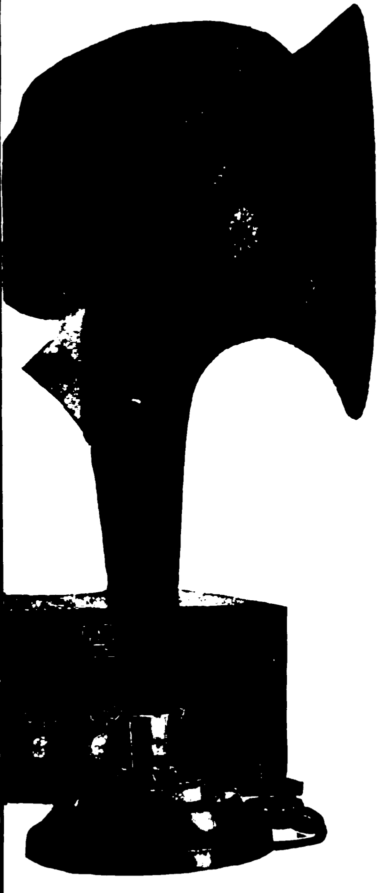
Made in two sizes
No. 251 for ¼" shafts No. 188 for 3/16" shafts

The UNIVERNIER	**$1.00**
Special silver plated 360 scale for use with the UNIVERNIER	**.25**
Complete	**$1.25**

At your dealers or postpaid on receipt of the above amount.
Discounts for jobbers and dealers.

WALBERT MANUFACTURING COMPANY, 933 Wrightwood Ave., Chicago, Ill.

P. S.—The UNIVERNIER will add to the appearance of any set.



A Real Musical Instrument

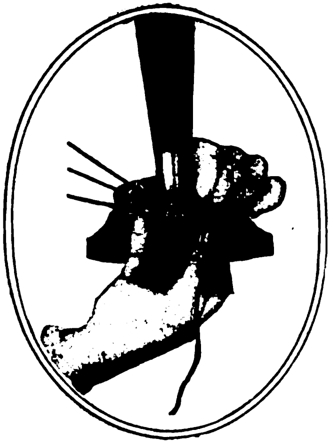
ACTUAL REPRODUCTION, of the artist's music, as broadcasted, is at last attained in the **Atlas Amplitone** Loud Speaker without blast or distortion. The artist's personality breathes again in the full, natural, vibrant tones of the Amplitone Re-PRODUCTION. Musical critics and radio fans, who have heard the Amplitone, agree that, at last, the musical superiority of even the finest phonographs has been surpassed. Embodies exclusive acoustic principles including the marvelous double diaphram.

Atlas
AMPLITONE
LOUD SPEAKER

◆ ◆ ◆

NO loud speaker is perfect, unless it can be adjusted to your own individual set. The **Atlas Amplitone** is adjustable to any set. Complete with connecting cord

$25



Amplitone Unit

The **Atlas Amplitone** Unit (without base or horn), with Grafonola Attachment, for use with your own horn or base or to convert any phonograph (except the Brunswick) into a loud speaker. With attachment.

$13.50

Write for Amplitone Booklet

Write for illustrated booklet and the name of your nearest *Amplitone* dealer. No other loud-speaker can take the place of the *Amplitone*.

Multiple Electric Products Co., Inc.

7 Orange Street

Newark, N. J.

TUSKA RADIO TRADE MARK

Thrills!!!

Thrills never end when you have a Tuska Popular—the regenerative receiving set that experts recommend. Signals clear and sharp come in night after night from faraway stations. And for nearby programs, plenty of volume without distortion. Every part Tuska-made; known for 12 years as fine radio instruments.

Tuska Popular No. 225
Regenerative Receiving Set, Tuska receiver, detector and 2-stage amplifier, licensed under Armstrong U. S. Patent No. 1,113,149. Catalog No. 15-A, showing Popular and other sets, on request

TUSKA RADIO

Qualitone

RADIO HORNS

$4.50

No. 1 Holds two phones.
No. 1R Holds one phone.
Beautifully finished in dark red mahogany
Equipped with a patented

DOUBLE TONE CHAMBER

that produces sweet tones and clear articulation. Guaranteed to produce plenty of volume if used with a two stage set.
THOUSANDS OF DEALERS are selling Qualitones. Ask your dealer to order for you if he is not supplied.

THE DUAL TOOL COMPANY
12325 Superior Avenue Cleveland, Ohio

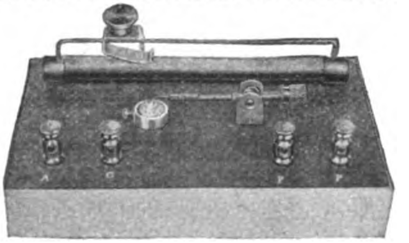
DEPENDABLE TESCO LINE

INSTRUMENT MAKERS SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



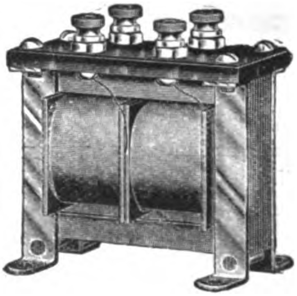
Without Phones or Aerial

TYPE "A" (Shown in cut) . . $1.25
TYPE "B" De Luxe . . $6.00
Type A (complete), $6.00 Type B (complete), $11.00

Sent prepaid upon receipt of express or postal money orders.
Money refunded if not absolutely satisfactory.
Dealers and Jobbers write for discounts.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

RITTENHOUSE TYPE W. D.



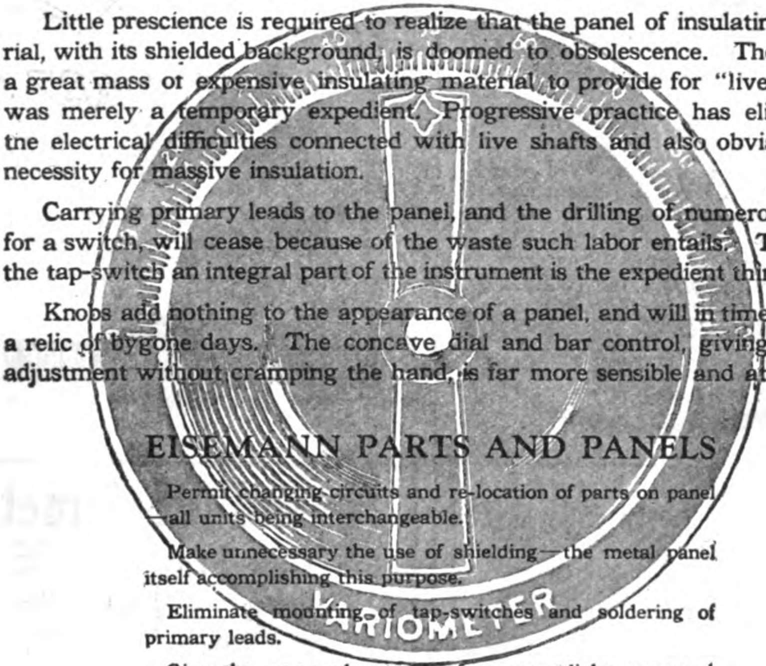
Audio Frequency Transformers are designed to be used in conjunction with **PEANUT TUBES.** Turns Ratio 3 to 1.

Price, $4.00
At your Dealer's, or postpaid upon receipt of price

THE A. E. RITTENHOUSE CO.
Honeoye Falls, N.Y.
Transformer Manufacturers for over 20 years

THE RADIO SET OF THE FUTURE

IT cannot be foretold what combination of units will be used, or the circuits that may be employed in the Receiver of tomorrow. It is obvious, however, that today's conventional set will soon be considered crude and antiquated.



Little prescience is required to realize that the panel of insulating material, with its shielded background, is doomed to obsolescence. The use of a great mass of expensive insulating material to provide for "live shafts" was merely a temporary expedient. Progressive practice has eliminated the electrical difficulties connected with live shafts and also obviated the necessity for massive insulation.

Carrying primary leads to the panel, and the drilling of numerous holes for a switch, will cease because of the waste such labor entails. To make the tap-switch an integral part of the instrument is the expedient thing to do.

Knobs add nothing to the appearance of a panel, and will in time become a relic of bygone days. The concave dial and bar control, giving ease of adjustment without cramping the hand, is far more sensible and attractive.

EISEMANN PARTS AND PANELS

Permit changing circuits and re-location of parts on panel—all units being interchangeable.

Make unnecessary the use of shielding—the metal panel itself accomplishing this purpose.

Eliminate mounting of tap-switches and soldering of primary leads.

Give the many advantages of concave dials—a natural **position of the hand in tuning, added attractiveness in appearance and ease in packing for transportation.**

Write for descriptive literature.

EISEMANN MAGNETO CORPORATION
William N. Shaw, *President*
BROOKLYN, N. Y.

DETROIT **CHICAGO**

—for panels!

Bakelite-Dilecto (xx grade) is the one material you can absolutely depend upon to be perfect for radio panels.

bakelite-dilecto!!

(*A Laminated Phenolic Condensation Product*)

It's handsome. It's tough. It's durable. Yet machines readily.

It resists heat, water, steam, fumes and mild acids. It cannot warp or swell.

Highest dielectric resistance. Used over 8 years in the U. S. Navy and Signal Corps. Have any electrical man get it cut and drilled to size.

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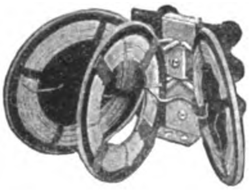
Four Way Switch Plug

ASK TO SEE IT

MANUFACTURED BY
THE FOUR WAY COMPANY
Springfield, Mass. U.S.A.

PRICE $1.50 PRICE $1.50

Tune into Results with this New and Better Device



MARCO TUNER

Type 300A

Body Capacity Practically Eliminated

. . . .

As a Single or Double Circuit Tuner

this instrument is most useful, particularly for tuning simple, efficient regenerative sets.

As a Radio-Frequency Transformer

it is the most generally satisfactory piece of apparatus on the market today, *providing in itself* an aerial tuning inductance and an intertube coupling impedance which is variable, compensating for changes in wave length or differences in inter-electrode tube capacities, allowing successful operation with any of the new *low amperage tubes.*

In the Flewelling Circuit

all the interesting phenomena of super-regeneration may be observed through the use of this device.

In Any Combination Requiring Small Inductances

this arrangement of coils will provide the necessary values for broadcasting reception, and will work well, with a pleasing lack of body capacity effect in adjustment.

MARTIN-COPELAND COMPANY
Providence, R. I.

Amrad Variometers

New Price $3.75

Most efficient variometer on the market. No dielectric losses, small mounting space required. New automatic machines used in manufacture brings their price within the reach of every Radio Fan. Immediate delivery on all mail orders.

Variometer, less dial	$3.75
Vario-Coupler, less dial	$3.85
Jefferson Transformers, No. 41	$4.25
Jefferson Transformers, No. 45	$7.00

New Loose-Leaf Catalog Now Ready

Contains complete description, circuit diagram and list of material for building the NEW GRIMES INVERSE DUPLEX RECEIVER.

Send 10c for your copy.
New sheets supplied free of charge every month.

LYNN RADIO CO.
Sixth Floor, Consumers Building
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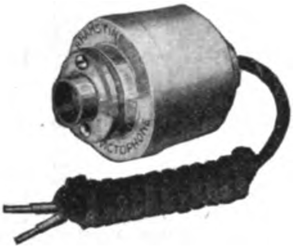
RHAMSTINE*

Victophone

A NEW LOUD-SPEAKER



Price

$7.50

Complete with Phone Cord

Remove the reproducer from your Victrola and put on the Rhamstine* *Victophone,* adjust the pole regulator until the tone and volume are just right—and see if it does not fully meet your needs for a perfect loud-speaker.

The *Victophone* is a correctly designed loud-speaking receiver—it requires no battery to operate it. It can be used with any type of horn but it is especially designed to be attached to the tone-arm of various phonographs.

It possesses these superior qualities:

1. **Adjustable poles.**
2. **A venturi opening in the cap correctly designed to increase volume.**
3. **Rubber gasket between the tone-arm flange and the cap to reduce metallic vibrations.**

The *Victophone* is nickel-plated and highly polished. It bears the name Rhamstine,* assuring you of satisfaction in your purchase.

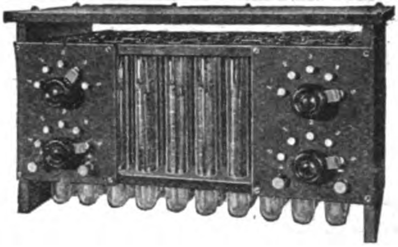
Order yours today. Dealers write for discount.

Manufactured by

J. THOMAS RHAMSTINE*

2162 E. Larned Street **Detroit, Michigan**

Maker of Radio Products



KICO Radio Storage "B" Batteries for EFFICIENT Receiving

1. KICO "B" batteries allow single cell variations by means of switches mounted on panels. (The first in the market with this feature.)
2. Alkaline type.
3. Rechargeable from your 110-volt A. C. line in connection with the rectifier supplied.
4. One charge lasts from three to six months in the detector plate circuit.
5. Neat, efficient and compact.
6. Unlimited life.
7. Your money back if unsatisfied within a 90-day trial.

	(Plain)	(With Panels)
16 cell 22 volt	$6.50	......
24 cell 32 volt	8.00	$12.00
36 cell 48 volt	10.00	14.00
50 cell 68 volt	12.00	17.00
78 cell 100 volt	16.00	21.00
108 cell 145 volt	21.00	26.00

"A" and "B" Battery Literature gladly furnished

KIMLEY ELECTRIC COMPANY
1357 FILLMORE AVENUE BUFFALO, N. Y.

BRANSTON RADIO

Branston Lateral Wound Honeycomb Coils

Manufactured Under Deforest Patents

The finished product resulting from many years' experience in coil winding.

They are the most efficient and practical radio inductance ever designed. Sold unmounted or mounted with Branston Standard Mountings.

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Turns	Unmounted	Mounted
L25	$ .50	$1.40
L35	.50	1.40
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L75	.60	1.50
L100	.65	1.70
L150	.70	1.75
L200	.75	1.80
L250	.80	1.85
L300	.85	1.90
L400	.90	1.95
L500	1.00	2.20
L600	1.15	2.35
L750	1.35	2.60
L1000	1.60	2.85
L1250	2.00	3.30
L1500	2.50	3.85

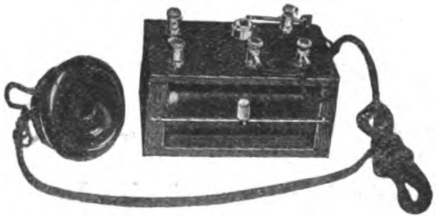
3 Coil Bakelite Adjustable Mounting $5.00
2 Coil Adjustable Mounting......... 3.50
Single Coil Mounts.................. 50c

Order through your dealer or write direct for complete catalog showing Branston "Standard" Radio Accessories.

CHAS. A. BRANSTON, Inc., 815 Main St.
BUFFALO, NEW YORK
In Canada, Chas. A. Branston, Limited, Toronto, Ontario

"VB" RADIO CRYSTAL SET

Very Simple and Efficient



PRICE

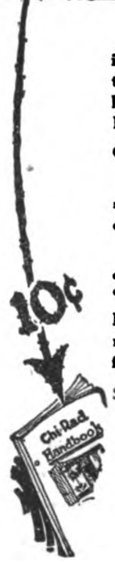
Without phone or antenna . .	**$1.25**
With single phone (1000 ohms) receiver and cord	**$3.25**
With phone and antenna equipment	**$3.75**

Satisfaction Guaranteed or Money Refunded

Sent prepaid to any address upon receipt of money order, or will send C. O. D. parcel post.

B. W. WHITEHURST
250 South Street Newark, N. J.

How to build the Reinartz Receiver



is told, complete with illustrations and diagrams, in the latest addition to the "Chi-Rad" Handbook-Catalog.

Our Handbook also includes:

1. **Technical discussions of standard radio apparatus and equipment.**
2. **Radio definitions, wireless codes, wire tables, definitions, etc.**

Pin this ad to your letter and mail it together with a dime for your copy of the Handbook.

Send for it, today !

Chicago Radio Apparatus Co.
415 S. Dearborn Street
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Federal

Is a Large User of Formica

THE FEDERAL TELEPHONE AND TELEGRAPH COMPANY of Buffalo is a large factor in the radio industry and has an excellent reputation for the quality of its product.

It is a very extensive user of Formica insulation not only in the complete sets which it produces but in the radio parts, variometers, variocouplers, headsets of which it is a large manufacturer.

A list of the users of Formica reads like a directory of the leading independent radio manufacturers. So many of the best informed radio men in America cannot be mistaken in their opinion that Formica is most uniform, the best looking, and the most efficient radio insulation.

Dealers and amateurs can safely follow these great concerns in selling or using Formica.

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Cincinnati, Ohio

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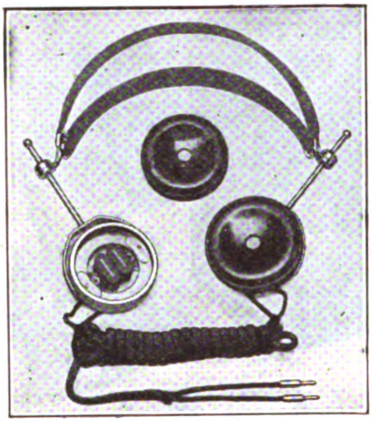
FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

RADIO

HEADPHONES



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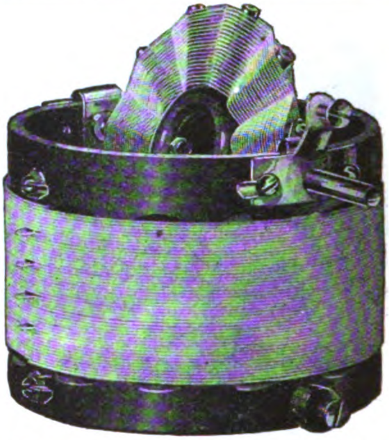
$8 LIST PRICE $8

2,200 OHMS **LOUD AND**
LIGHT WEIGHT **CLEAR**

Dealers May Send
$3.20 for Sample

Add 20 cents for postage **MONEY BACK GUARANTEE**
Write Dept. A-23

C. M. FRENCH MFG. CO., Seymour, Conn.



HARTMAN VARIOCOUPLER

WITH

SPIDER WEB ROTOR

PROVIDES
REMARKABLE SELECTIVITY IN TUNING
Designed for us by Alfred A. Crossley

Price $6.50

Write for bulletins on Hartman Radio Products

THE HARTMAN ELECTRICAL MFG. CO.
MANSFIELD, OHIO

Listen in with a

Dodge TONE AMPLIFIER

A scientifically perfect instrument, with wood pulp sound chamber, designed by one of the foremost acoustical specialists. This Perfect Tone

RADIO LOUD SPEAKER

insures the most delicate reproduction of voice or music and positively eliminates distortion and metallic sound.

The Dodge Tone Amplifier is enclosed in a handsome mahogany cabinet, with front panel and sound chamber finished in black. Size of complete outfit: 12 in. high, 9¾ in. wide, 8¼ in. deep.

The Dodge Tone Amplifier is made especially for home use, with any set of three tubes or more. No batteries necessary. No adjustments. Complete, ready for immediate use. Merely hook up and listen. Price...... **$25.00**

Liberal Discounts to Jobbers and Dealers

ACKERMAN BROTHERS COMPANY, Inc.
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Announcement to our Numerous Friends!

Beginning May 1, 1923, the

MORTIMER RADIO CORPORATION

and the

ADVANCE METAL STAMPING CO.

both of New York City, will consolidate and be known in the future as

AMSCO PRODUCTS, INC.

The "Melco Supreme" Radio-Frequency Receiver will continue to be marketed under its own name and a complete line of high-grade parts will be available at good dealers under the Amsco brand.

Our new home in the

Fairbanks Building
Broome & Lafayette Sts. **New York City**

is up-to-date in every respect and will enable us to give even better service than has heretofore been possible.

A postcard will bring you our literature—describing both sets and parts.

Thank You!

Red Seal SPARKER—steel clad

for every outing

Red Seal Radio Sparker

Specially designed for operating W D-11 Tubes. Radio Sparkers give nearly three times longer service than a single dry cell. Made in 2-cell, 6-cell and 8-cell sizes for operating one to four W D-11 Tubes.

For economical operation specify **Radio Sparkers.**

This summer let the Red Seal Sparker—steel clad—supply dependable power for your outing needs. A fat, full spark for your motor boat ignition—a quick, sure start for your car—lighting up your camp lantern—Red Seal is always on the job, long lived, efficient.

For tractors, stationary engines, and so forth, farmers also find Sparkers—steel clad—stand all kinds of hard knocks.

The Red Seal Sparker—steel clad—is made in three sizes: 4 cells, 6 volts; 5 cells, 7½ volts; 6 cells, 9 volts.

Be sure to ask for it by name—Red Seal Sparker—steel clad.

MANHATTAN
ELECTRICAL SUPPLY CO., INC.

Makers of the famous Red Seal Dry Batteries,
Sparkers and Manhattan Radio Products.

New York **Chicago** **St. Louis** **San Francisco**

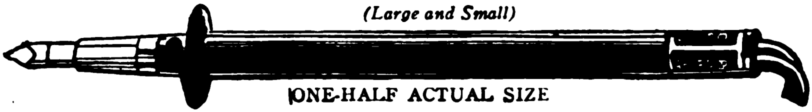
DELICATE SOLDERING in RADIO

Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tips—Universal Current

(Large and Small)



ONE-HALF ACTUAL SIZE

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York

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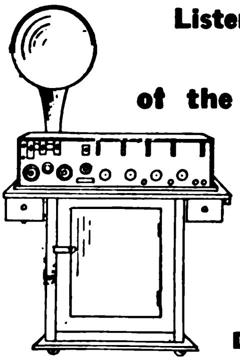


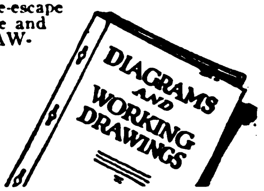
Listening across the continent—New York to California

ORIGINAL BLUE PRINTS

of the Famous MAWHINNEY RECEIVING APPARATUS

A series of 7 blue prints giving in full detail all the necessary information, specifications, and method of construction, and assembling of the MAWHINNEY RECEIVING Apparatus. This is the 5-tube receiving set that startled the radio world by picking up 5 stations on the Pacific Coast with only a fire-escape as an aerial. The Blue Prints tell you in a very simple and clear manner just how to construct a duplicate of MAWHINNEY'S trans-continental receiving set.

If your dealer cannot supply you—
Send $2.00 for complete set of prints.



A. S. MAWHINNEY

Dept. 31 801 Riverside Drive, New York

RADIO BLUEPRINTS

Blue Print Design of Radio Receiver, guaranteed range 1,000, 3,000 miles, using dry cell	10c
Blue Print Two Stage Amplifier for above outfit	10c
Blue Print of Radio Frequency Amplifier for above	10c
Guaranteed 1000 Ohm Phone Receiver Postpaid	$2.00
Guaranteed Bakelite Couplers, Green Silk Prepaid	$3.00

We sell Guaranteed Apparatus.

Send 10c for Our Complete Catalog!

Agents Wanted—Liberal Commissions

Badger Radio Co., 493 E. Water St., Milwaukee, Wis.

FREE Radio Catalog

Our big stock of standard makes of radio sets, parts and supplies, fully illustrated. Play safe—buy standard equipment from a reliable house. We ship from stock.

Send $5.00 for Murdock Loud Speaker, including fibre horn, stand and adjustable phone unit. Requires no battery.

JULIUS ANDRAE & SONS CO.

In business since 1860

127 Michigan Street Milwaukee, Wis.

DUCK Radio Pioneer Announces Startling Reductions

Leading Line Since 1909 At Prices to You Less Than Dealers' Cost

FREE Illustrated pamphlet comprising sixty-two Duck radio instruments and sets with reductions averaging 30% mailed on request. Send postal today. Any old-time radio amateur will tell you who we are and our reputation. Only a few years ago almost one-third of the radio instruments sold at retail, exclusive of sales in only a half dozen large cities, were sold by Duck.

A Few of the Many Duck Products at Sensational Prices:

Rheostat, 70c; Bakelite moulded positive contact Socket, 70c; Bakelite Moulded Dial, 55c; superselective moulded variometer, $4.65, worth $8.00; radio frequency potentiometer, $1.15; solid mahogany form variometer, $3.60; 43-plate panel-type variable condenser, pigtail connection, $3.15; detector panel, $5.25; receiving set, mahogany cabinet, detector and two stages of audio frequency, $59.50; radio frequency receiving set with one-step radio and detector, $29.75.

SEND 25c in coin or money order for our big 256-page combined radio catalog and text book. For radio information and hook-ups it is worth many times the retainer asked.

THE WILLIAM B. DUCK COMPANY, 227-229 Superior St., Toledo, Ohio

Dependable Radio Sets and Service

Can always be had from local dealers who have been honored with the

M.R.C. FRANCHISE

For Three Reasons:

1. Franchise is granted only to merchants of standing and financial responsibility, with sufficient technical experience to render intelligent service.
2. "Michigan" Radio Sets are the finest examples of correct Regenerative radio engineering, expressed in superlatively good workmanship.
3. The Michigan Guarantee is as valid as a Bond. For back of it stands the strongest independent Radio manufacturing concern in the United States.

"SENIOR" SET

Michigan Regenerative Receiving Sets

are built under Armstrong License (U. S. Pat. 1,113,149 and letters patent No. 607,388). This means that they embody the latest development in Regeneration—the soul of radio.

Long Distance Wonder Workers

"JUNIOR" SET

The "Senior Set" includes both detector and amplification, and can be used with either headphones or loud speakers or both.

The "Junior Set", a detector unit only, is limited to headphone reception. It can however, be hooked up with the Michigan Amplifier unit for loudspeaker reception.

Send for the Michigan Circular, giving full information on both sets and parts, and telling of some of the long-distance triumphs of Michigan set owners.

MICHIGAN RADIO CORPORATION

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You need the Most Authentic Book on Radio—compiled by the U. S. Bureau of Standards—350 pages of valuable and essential data. Only......... **$1.00**

Specials for this month only

Single Circuit Jacks	$ .50
Double Circuit Jacks	.60
Audio-Transformers	4.00
Plugs (2 phones)	.80
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45 Volt "B" Battery	3.25
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Variocoupler, 180 degree	3.50
Freshman Variable Resistance Leak and Condenser	1.00
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Fremont Precision, 43 Plate	2.50
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Vernier Bakelite Ends, 43 Plate	5.00
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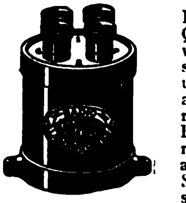
10c will bring you our new and up-to-date catalogue illustrating and describing our entire line—containing diagrams and other interesting data of value to radio fans.

All merchandise guaranteed by both the Manufacturer and ourselves. Shipped immediately on receipt of purchase price and postage.

THE NEW RT-8



Radio Frequency Transformers are specially designed by the **Radio Service LABORATORIES** for maximum efficiency when used with any low current consumption tubes on the market.

For Audio Frequency, the new RT-A2 will give you 100% Tone Quality and High Amplification without distortion. For best results on both tone and distance, use Radio Frequency RT-8 (for all stages) in the black case, retail price $6.00, and Audio Frequency RT-A2 in brown case, retail price $6.50. For sale at all reliable electrical or **Radio** Stores. If your dealer cannot supply you, order direct. Order by type number, accept no substitute, and remember that all **Radio Service Laboratories'** Transformers are individually triple tested and unconditionally guaranteed.

Send ten cents for booklet on Radio Frequency with schematic diagrams—a most valuable and helpful publication for the radio amateur and expert.

RASLA SALES CORPORATION

National Distributors

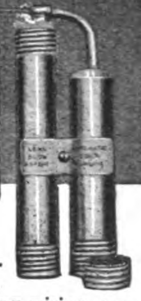
DEPT. P, 10 E. 43rd ST. NEW YORK CITY

WE LIVE IN KANSAS

But we receive programs from Atlanta, Minneapolis, Davenport, Fort Worth, Dallas, Kansas City, St. Louis, Denver, San Antonio on crystal without batteries. Your crystal set requires only easy, inexpensive changes. Send stamp for further information, or $1 for copyrighted drawing and instructions. Everything clearly explained. Satisfaction guaranteed. LEON LAMBERT, 505 South Volutsia, Wichita, Kan.

Solder it with a LENK ALCOHOL BLOW TORCH

No Pumping
No Priming
Blows Itself



Here It Is

The handiest tool ever devised for soldering connections on Radio sets, repairing wiring connections in your house and on your car, mending kitchen utensils.

Fine for close, careful work. Produces a 1400° needle-point flame instantly. Used by electricians and mechanics everywhere.

60-in. coil self fluxing (acid or rosin core) solder	.25c
Lenk Super (blows itself) torch	75c
Lenk Jumbo (blows itself) torch	$1.00
Marvel Soldering Kit—one Lenk Jumbo Blow Torch and two coils—one acid and one rosin core—self-fluxing solder, in neat leatherette case	$2.00

LENK MFG. CO.

40 Portland St. Boston, Mass.

DELFELCO RADIO B BATTERIES ARE GUARANTEED

Small 22½V	$2.00
Small 45V	4.00
Large 22½V	3.00
Large 45V	5.50

Postage Paid

DELFELCO BATTERY CORP.

11 MEETING STREET PAWTUCKET, R. I.

GIVE YOUR EARS A TREAT!—USE

"RED-HEADS"

3000 Ohms

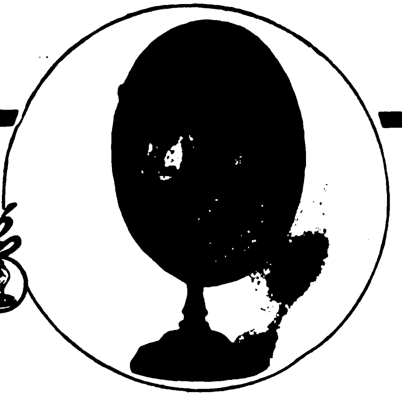
With Military Head-Band and Cord

Now $6.50

At your dealers or direct on receipt of price.

A Triumph in Radio Receiver Design

The Newman-Stern Co. Newman-Stern Building Cleveland, O.



The New Pathé

Reproducing Revolutionized

Based on our experience of over a quarter of a century, as manufacturers of musical instruments—and as highly specialized acoustical engineers, we have produced the PATHÉ LOUD SPEAKER which will mark a new era in loud speakers.

It is something decidedly different. It utilizes an entirely *new* principle. And as a result it converts tone with an exactness never before accomplished by a "loud speaker."

No horn of any type is used. No small metallic diaphragm is hidden away at the end of a horn or in the depths of a cabinet. What you suppose on first inspection to be a stubby sort of a horn, is a parchment diaphragm of abnormal size.

WITHOUT DISTORTION the sounds are given directly from this diaphragm, propagating the waves in free air rather than by reflection from the sides of a horn device.

The Pathé Loud Speaker possesses an unrivaled combination of distinct advantages. Briefly:—

It distributes the sound in all directions—and *does not* confine or "shoot" it toward one point as a horn does.

It does not require an extra battery. Simply attach it in place of the ear phones.

On the home sets of two steps of amplification it will flood the room with clear tone. On larger sets, it will produce any volume of sound required— WITHOUT DISTORTION.

It is compact, size 14¼" high x 7" wide, and it will grace any living room.

The cost is much lower than you expect—

$24 for nickel finish
$22 for Japan Green finish

If your dealer has not received his Pathé Loud Speakers, we will make you shipment direct from the factory. Simply enclose money order or check and say, send me The Pathé Loud Speaker.

Pathé Phonograph & Radio Corp.
Dept. 4355, 20 Grand Ave., Brooklyn, N. Y.

Send the Coupon

Pathé Phonograph & Radio Corp.,
Dept. 4355, 20 Grand Ave., Brooklyn.

Please send me the Pathé Loud Speaker.

I am enclosing $............ It is distinctly understood that I may return the Loud Speaker if it is not entirely satisfactory—and my money will be cheerfully refunded.

Name ....

Address ....

Town ....

Pathé the World Over

1200 MILES
with a Crystal Set Using

MPM
MILLION POINT MINERAL
THE WORLD'S GREATEST RADIO CRYSTAL

A Needles, California, radio fan writes:

"Using M. P. M. Crystal, I picked up Los Angeles, San Francisco, Salt Lake, Denver and St. Louis. It is far superior to any crystal I have ever used."

Before discarding your Crystal Set for an expensive Tube outfit, give M. P. M. Crystal a trial!

¶ ***Beware of imitations!*** The genuine Million Point Mineral is sold only in separate crystals packed by our company in boxes bearing the trade-mark "M. P. M."

Send 25c and name of your Radio Dealer for a sample M. P. M. Crystal—concert-tested and guaranteed. 35c for mounted Crystal.

M. P. M. SALES COMPANY
Department PR
247 So. Central Ave. Los Angeles, Cal.

PRICES *SMASHED*

Each sale has created new friends and customers, with the result that we now announce drastic reductions in our quality lines. All goods prepaid. Send card for complete list. You'll be surprised. You'll tell your friends. A sample saving follows—

Complete Regenerative Vacuum Tube Set

(Knocked down. Approx. range 1000 miles.)

	Our price	Others
Panel 7" x 12"—Bakelite—drilled	$1.75	$2.50
Cabinet of 3 ply wood to fit above panel	1.50	2.50
Two 3" dials @ 35c each	.70	1.40
16 switch points with nut @ 1c each	.16	.48
4 switch stops with nut @ 1c each	.04	.12
8 nickel plated binding posts @ 3c each	.24	.48
2 switch levers @ 25c each	.50	.90
1 filament rheostat. Highest grade	.65	1.10
1 vario-coupler with 7 multiple, 7 single taps	2.25	4.00
1 23 plate variable condenser. Built right	1.95	3.50
1 tube socket—High grade	.45	.85
1 grid condenser and leak	.20	.35
1 phone condenser	.15	.30
1 support for tube socket	.15	.25
10 feet of spaghetti tubing @ 5c per foot	.50	.84
15 feet copper connecting wire	.15	.30
Blueprints showing details to assemble outfit	.10	.25
	$11.44	$20.12

Other articles taken at random from our list are:

Detector tubes—Cunningham—New. NOT rebuilt	$4.25	$5.00
Amplifying tubes—Cunningham—New. NOT rebuilt	5.50	6.50
Transformer—Audio frequency. United	2.95	4.50
Variometer—Hardwood Stators 4¾" square. Assembled Workrite type	2.45	4.00
Frost Fones ......2000 ohms	3.95	5.00
Dictograph ......3000 ohms	6.50	8.00
Stromberg Carlson..3000 ohms	5.95	7.50
Murdock ......3000 ohms	4.75	5.50
Holtzer Cabot ....2200 ohms	6.25	8.00
Manhattan ......2000 ohms	4.95	6.00
Manhattan ......3000 ohms	5.50	7.00
Two stage amplifier—Knocked down. Cabinet and drilled panel	12.95	23.50
Blueprints giving detail of two stage amplifier	.10	.25

Send for full list today or order from above. Goods sold subject to return for rebate or exchange. YOU SIMPLY MUST BE PLEASED.

RADIO PARTS MANUFACTURING CO.
Dept. "P" 2150 Montclair Detroit, Mich.

In Any or All Stages
of audio frequency amplification
The AMERTRAN

can and should be used. It is made in only one type and one ratio. Its flat-top amplification curve precludes the possibility of distortion on the part of the transformer when used in any or all stages.

It will give the same clear-toned distortionless amplification with all tubes which are approximately alike in A. C. Impedance and Amplification Factor, such as

WD-11
UV-201 UV-201-A
C-301 C-301-A

Price $7
Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

Its amplification in one stage is 38.6; two stages 1490.

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

Determines RANGE of YOUR SET
$1 Complete

Determines DISTANCE of CALLS RECEIVED
$1 Complete

THE McNEARY
RADIO SCALOMETER
AND OFFICIAL RADIO MAP

After you recover from the thrill you get every time you tune in on an out-of-town station, the first thing you want to know is HOW FAR was that?

With the Scalometer mounted on the official map you read the distance directly on the tape—instantly and correctly.

SCALOMETER
An instrument of precision in a beautifully finished aluminum case.

RADIO MAP
Authoritative, up-to-the minute, showing broadcasting stations time zones, radio districts, cities and towns of the United States and Canada.

BROADCAST DIRECTORY
In handy booklet form with all broadcasting stations alphabetically arranged by call letters.

IF YOUR DEALER CANNOT SUPPLY YOU SEND ONE DOLLAR TO

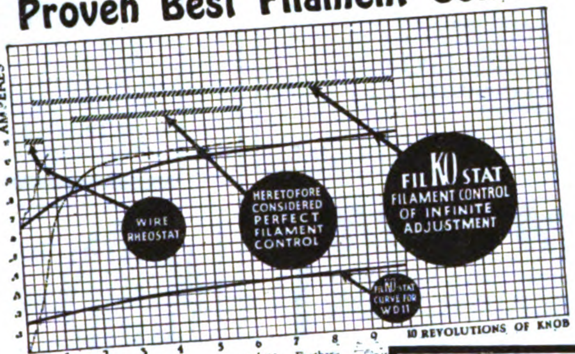
EMBLEM MANUFACTURING CORPORATION
255 MIDDLE CITY BLDG., PHILADELPHIA, PA.

Read this again!!

1839

adio N fo April, 1923

Filkostat Proven Best Filament Control



Comparison of Fine Adjustment Control Range of Filkostat With Rheostats and Other Filament Controls Clearly Indicates Filkostat Superiority, as it Permits Perfect and Gradual Current Increase With Infinite Adjustments.

IN the Filkostat, a new filament control just perfected by S. R. Hipple, well known as an inventor of apparatus for the control of electric currents, there is at last presented an instrument which is distinctly designed to utilize the great tuning possibilities of the vacuum tube itself. Radio set builders, amateurs and manufacturers have been looking forward to the advent of just such a device. They have realized that all rheostats and other so-called filament regulators, are merely adaptations of pre-radio day devices, not capable of adjusting the infinitesimal graduations of filament HEAT which adjustments are essential to perfect tuning.

PERFECT TUBE CONTROL

The Filkostat permits perfect regulation of filament heat. Since the heat emitted varies as the square of the current, fine current regulation becomes extremely necessary to accomplish. This governs the flow of electrons. Proper control of the electronic flow in the tube permits the very finest tuning conceivable. The fine adjustment of the Filkostat starts slightly before the tube begins to function. With other filament controls, what minute adjustment there is, starts when the filament is almost at maximum heat. Between 1800 degrees—dull red glow—and 2050 degrees—white heat—the Filkostat control is so fine that increases of temperature of *fractions of a degree*, with corresponding variations of electronic flow from the filament to the plate, are obtainable.

LONGER TUBE LIFE; NO NOISES

The initial inrush of current prevents the crystalization of the filament which so many experts claim occurs when the current is fed too slowly at first as is done in other forms of filament controls. This means considerable increase in tube life. Furthermore the extreme degree of fineness in increase and decrease of electronic flow by infinitesimal variations, makes the Filkostat control ideal.

The perfection of design including ample internal contact is the cause of this new instrument being non-michrophonic, absolutely silent, and free from all noises.

IDEAL FOR WDII'S AND DX WORK

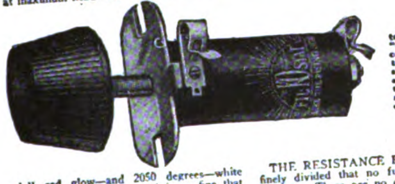
The lower curve on the graph above is eloquent testimony as to the Filkostat's adaptability to any dry cell tube. These tubes using only a fraction of an ampere demand an instrument that is so finely adjusted that this fractional current can be perfectly regulated. This the Filkostat accomplishes.

OTHER FILKOSTAT FEATURES

The Filkostat has a *definite off*. It is so designed that the filament extinguishes abruptly indicating that the A battery supply is completely disconnected.

At *Full On* the Filkostat resistance is practically zero.

The Filkostat consists of a hollow cylinder containing the special resistance material placed between two large adjustable contacts controlled by turning the knob.



The Filkostat is to all purposes "fool proof." It is compact in form, takes very little space on the panel and so mountable that it can replace any other control without redrilling.

THE RESISTANCE ELEMENT is so finely divided that no further division is possible. There are no disks to break or chip.

The RESISTANCE remains CONSTANT at any position eliminating current variations once set. Such variations are not apparent to the person tuning excepting in "fading out" of stations and noises. But in the laboratory, where such a test as that shown on the above graph can be made by anyone, this feature and all the other points of superiority of the Filkostat are immediately apparent.

Replace Old Style Current Controls with the
NEW FIL-KO-STAT *a real Filament Control*
ON SALE AT RADIO DEALERS EVERYWHERE

Manufactured By
DX INSTRUMENT CO
HARRISBURG PA

If your dealer has none in stock yet send $2.00 and his name direct to
SOLE INTERNATIONAL DISTRIBUTORS
RADIO STORES CORPORATION
Dept. P.B. 5
218-222 West 34th Street, New York

The filament kontrol
KO
of infinite adjustment
FIL-KO-STAT

CURRENT INCREASE PERFECT AND GRADUAL

LIKE THE RISING SUN

$2.00

—and here's why you need it!!

Designed For Vacuum Tube
adjustment and not just an old method adapted to it.

NOT a Rheostat
—but a REAL *Filament Control.*

Infinitesimal Control—of filament heat
and therefore of *electronic flow.*

Very Finest Tuning for DX
is realized with Fil-Ko-Stat.

Controls Fractional Currents
—making it ideal for use with any dry cell tube.

Fine Adjustment Starts
—where tube commences to function increasing the AREA OF FINE ADJUSTMENT CONTROL.

Definite Off—
an important feature indicating complete 'A' Battery disconnection,

Resistance Practically Zero
at "full on" there is practically no resistance in circuit.

No Disks To Break or Chip
Resistance Element is so finely divided further division impossible.

Absolutely Silent
The Fil-Ko-Stat is non-microphonic and operates free of all noises.

Fahnestock Clips
and solder contacts on connection posts.

Adjustable Mounting
—no re-drilling of panel neccessary.

GUARANTEED

The FIL-KO-STAT is to all purposes "fool proof". Each instrument is packed with the maker's guarantee that it will be replaced if broken within one year.

RUSONITE

CRYSTAL RECTIFIER

MULTIPOINT

(Patent Pending)

A Synthetic CRYSTAL DETECTOR sensitive over its entire surface

Eliminates all detector troubles. Extraordinary clearness and volume. Endorsed by radio experts and press. Sold in sealed packages only. Join the ever-increasing Rusonite fans.

Price, postpaid, mounted Sensitiveness guaranteed 50c

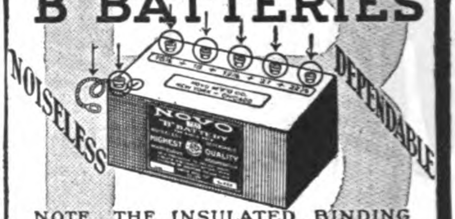
RUSONITE CATWHISKER 14-Karat Gold Multiple contact. Supersensitive 25c

Order from your dealer or direct from us.

Rusonite Products Corp., Dept. "P," 15 Park Row, N.Y.

NOVO

"B" BATTERIES



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424 W. 33rd ST.
NEW YORK

531 SO. DEARBORN ST.
CHICAGO

LEARN RADIO

Here's your opportunity. Radio needs you. Win success in this fascinating field. Trained men in demand at highest salaries. Learn at home, in your spare time.

Be a Radio Expert

I will train you, quickly and easily, to design, construct, install, operate, repair, maintain, and sell all forms of Radio apparatus. My new methods are the most successful in existence. Learn to earn

$1,800 to $10,000 a Year

FREE Wonderful, home-construction, tube receiving set, of latest design.

Write for "Radio Facts" free. Engineer Mohaupt.

American Electrical Association

Dept. 55 4513 Ravenswood Ave., Chicago

MOON RECEIVING SETS

THE MOON RADIO CORPORATION

Manufacturers of

Ultra-fine Receiving Sets

12 Diagonal Street
Long Island City, N. Y.

RADIO-PATENTS

Procured. Send sketch or model today for examination, prompt report and advice. No charge for preliminary advice. Write for free Booklet and blank form on which to disclose your idea. Highest references. Promptness assured.

CLARENCE A. O'BRIEN

Registered Patent Lawyer 1036 Southern Building, Washington, D. C.

A Message to Radio Dealers and to Other Members of Popular Radio's Fast Growing Family

This issue of POPULAR RADIO which you hold in your hands is our First Anniversary Number. It was just one year ago that POPULAR RADIO, even then a healthy youngster, first saw the light of day.

Since the issue of May, 1922, the magazine has made a host of admiring friends. Our little family of subscribers has grown to number approximately ten thousand. Our newsstand friends total close to a hundred thousand.

In almost every city and village where radio sets are in operation POPULAR RADIO is giving its readers practical hints and suggestions on how to build their own sets, how to widen their range, how to make improved hook-ups—is bringing to the radio novice and amateur the most authoritative information that can be had.

You, as a reader and friend of POPULAR RADIO, can help us to make this magazine still more useful and valuable by calling it to the attention of new readers. On page 60 of this issue you will find an attractive list of premiums offered for new subscriptions. Read it carefully. We also offer liberal cash commissions for subscriptions. Why not write us and get full details regarding our agent's proposition? It will help you to make good money in your spare time, and it will help us, also, to give you in the months to come a still bigger, better magazine.

Simply address Dept. 51 and we will tell you how you can make from $3 to $5 a day and more. To radio dealers who write us on their business letterheads, we also have an interesting offer. Ask for it!

POPULAR RADIO, Inc.

9 EAST 40th STREET Dept 51 NEW YORK CITY

It's Only a Step For You Now to a Big Paying Radio Position

SURELY you have noticed how wireless is spreading over every part of the world. Every day you learn of some new field that is utilizing it—some new firm organized to push it forward. But do you realize that YOU can easily qualify for the wonderful opportunities that are opening? Do you know that you can quickly build up a complete knowledge of Wireless—and be ready any time you wish to for a fine Wireless position, either on land or on sea? Through our special method of home-study instruction a short period of your spare time can be turned into preparation for a worthwhile future in the fastest-growing field in America today—Wireless. No one is in a better position than you to cash in big on the wireless expansion that is sweeping over the world. You have the whole foundation, all ready to build upon. Our new easy method of instruction makes the rest pure fun—but fun that pays big.

Commercial wireless expansion is sweeping over the world like wildfire! Big opportunities are open—and every day get more numerous and attractive. You are in a fine position to cash in big on this growing field. Right at home in spare time you can easily build upon your present knowledge and quickly qualify. The coupon below will bring you an interesting free booklet—telling about the splendid opportunities open, and how you can share them. Mail coupon for booklet today!

New Method Makes It Easy to Qualify

Both on sea and on land a fine future awaits the man who is qualified in wireless. No matter whether you wish to visit every nook and corner of the world or whether you prefer a land station, wireless awaits you.

Without obligation to yourself we would like to tell you more fully about the future wireless offers you. We would like to tell you about our Institute, which is officially recognized by the U. S. Government. The National Radio Institute was the original and is today the oldest and largest school in America teaching wireless by mail. The Government allows our graduates five to ten points credit when taking First Class Government License examinations. We have graduates in almost every part of the world who have quickly qualified through our special new method.

This method not only includes a comprehensive course of instruction written exclusively for us by some of America's greatest wireless experts (members of our own staff), but also includes, Free, a wonderful new invention patented and controlled only by us. This device, called the Natrometer, teaches you in half the usual time how to send and receive with speed and accuracy. This Natrometer is superior to any other device of its kind. Without aerials or any outside device it sends you any one of 600 different messages at a speed which you can vary from 3 to 30 words per minute. It is portable; also very attractive in appearance. It is noiseless; and it sends in a natural manner, not like a mechanical device. You get the messages thru its phones at whatever speed you wish. And this is **only one** of the features which our new method brings you. Others are listed below. Read them and you will realize why our students quickly qualify and why they step into the fine wireless positions that are waiting!

10 Points That Make This School the Best

1. **New Easy Method of Instruction.**
2. **Wonderful Natrometer and 3 other instruments to give you practical instructions at home.**
3. **Government Credit and Recognition.**
4. **Our Location in Washington—Passing New Official Developments on to You.**
5. **Personal, Individual Attention of Great Experts.**
6. **Our Service in Obtaining You Employment.**
7. **Free Training in Wireless Telephony.**
8. **Unlimited Consultation and Advisory Service.**
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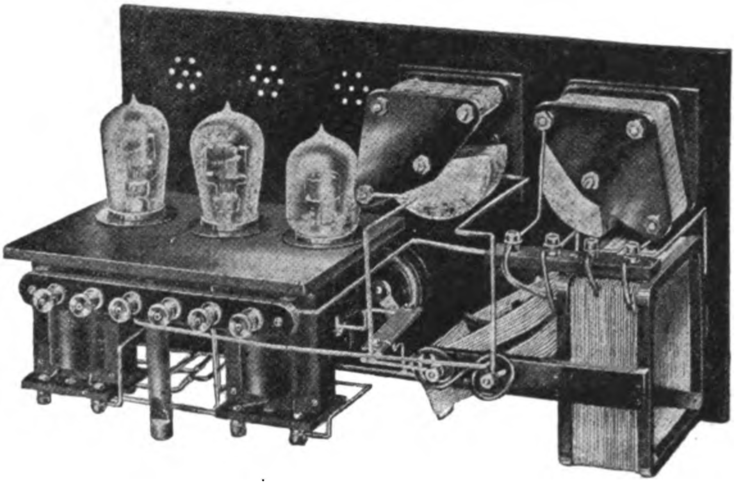

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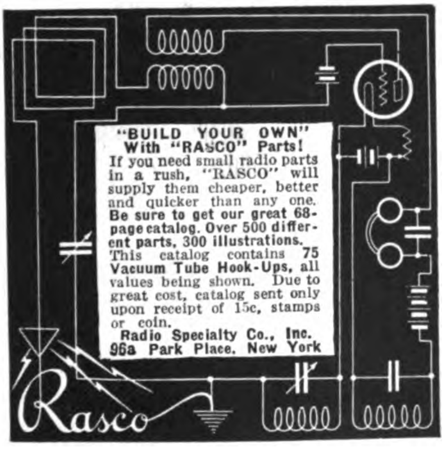

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SEE PAGE 60
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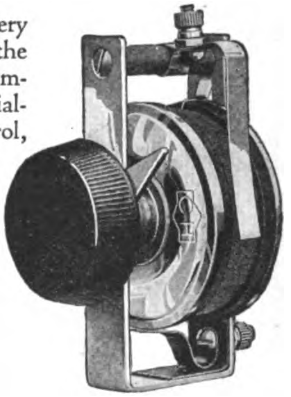

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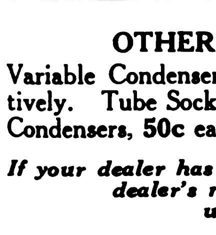

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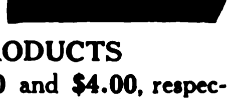

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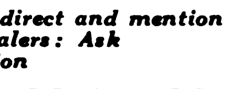

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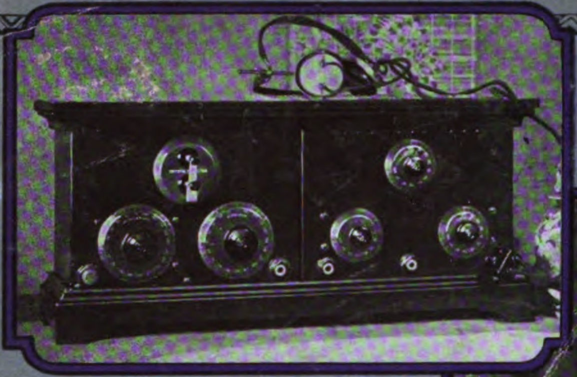

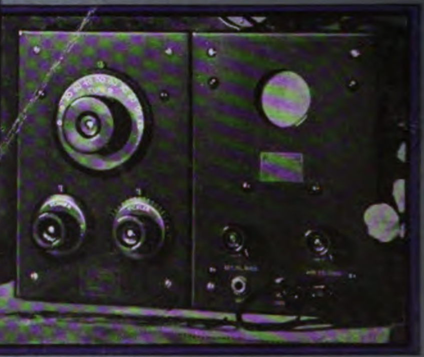

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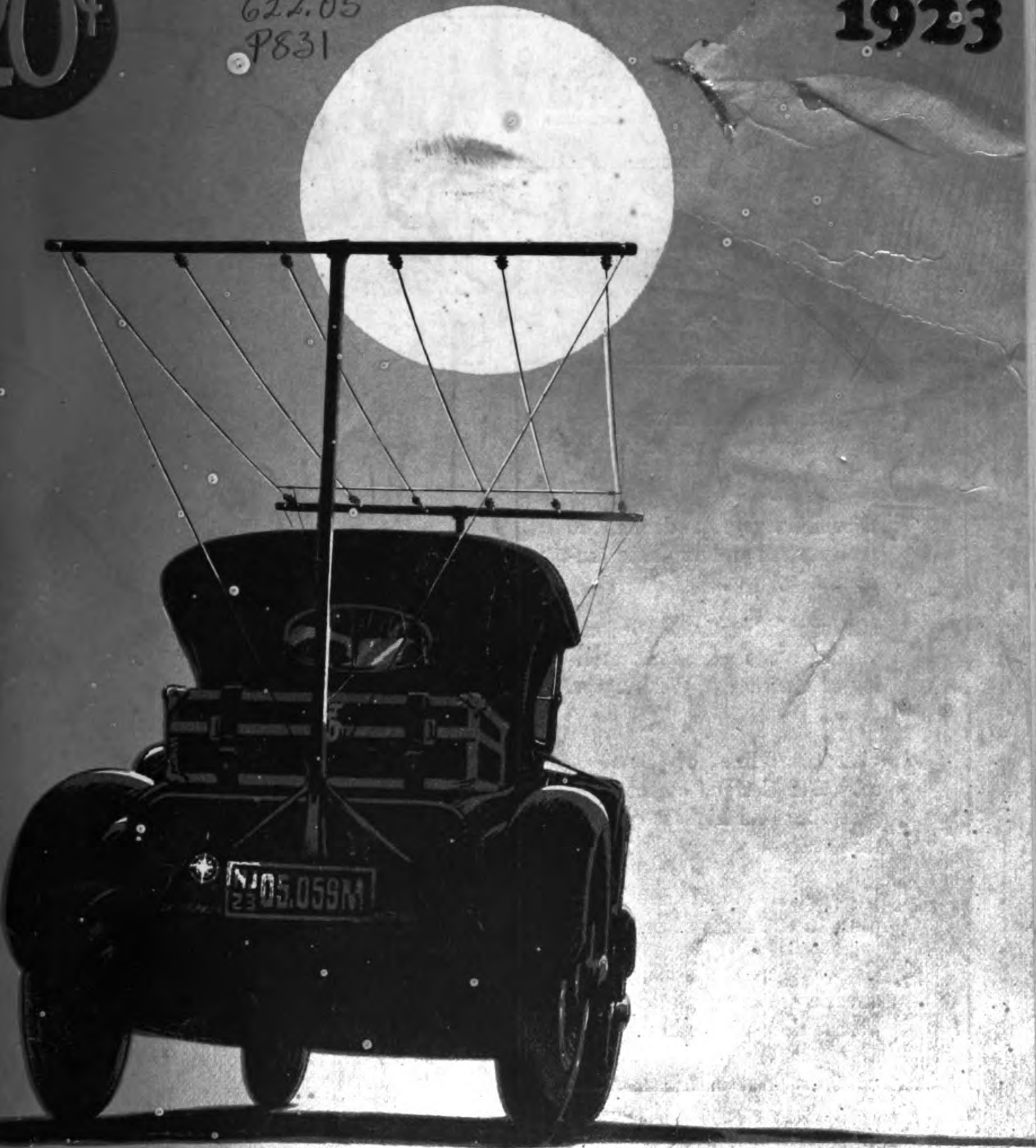

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6. Complete merchandising plan covering every phase of a profitable business in radio.

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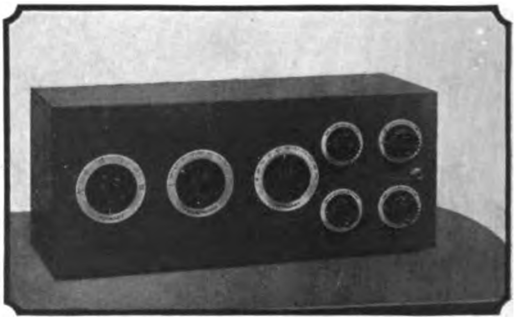

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Radio Headsets

POPULAR RADIO

EDITED *by* KENDALL BANNING

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(*Cover design by Frank B. Masters*)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

"He who lightly promises, is sure to keep but little faith"—Lao Tzu
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A PAGE WITH THE EDITOR

Just what features of Popular Radio are of the greatest interest and value to our readers? What kinds of articles do they prefer? Which of our departments are "getting over" most effectively?

To enable the Editor to meet the desires of our readers to best advantage, to make it possible for him to know their wants, a questionnaire has recently been sent out to a selected list of 3,500 subscribers. The replies are pouring in as this number goes to press.

* * *

When these replies have been classified and studied, the Editor will have a word or two to say to our readers—to their advantage.

* * *

General Squier's call upon the readers of Popular Radio—in our April number—for a suitable word or term that might be applied to that particular type of broadcasting which he discovered and which is based on wired wireless principles, has brought interesting responses from all over this country and Canada. One of the most original comes from MacArthur Morgan of St. John, P. Q., who proposed the apt term *Squiercasting.*

Well, why not? Were not the names of Henry and Watt and Ohm and Ampere and countless other inventors and discoverers perpetuated in the same way by being incorporated in the language of science?

* * *

"As the wireless wave is led along the leads of a transmission system," suggests Henry N. Potter, of Glendale, California, "why not term the system *leadcasting?*"

* * *

"Why not call it *directcasting?*" proposes E. W. Moreau, of Detroit. *Radiowire* is the term coined by B. Loudon, of Washington, D. C. Among other words submitted are *relay-casting, linecasting* and *recasting.*

* * *

Who says that the Middle West is not alive to its opportunities? From Flint, Michigan, came in the first nine-year-in-advance subscription to Popular Radio—accompanied by a check from Mr. F. Pruchnicki. If the magazine increases in size during that period proportionately as it has during the past year, by 1932 it will consist of 35,840 pages!

* * *

Here's a pertinent word of warning from A. D. Twinbull of Sidney, N. S.: "Even we Canadians," he writes, "have to be at the bookstalls early to get Popular Radio; it sells out quickly up here."

(For the benefit of our Yankee readers, we may explain that the English word *bookstall* translated into American is *newsstand.*)

* * *

But the dangers of being left out in the cold without a copy of Popular Radio are not confined to our neighbors up north. Right here in little old New York an insistent radio fan applied at eleven large newsstands on April 10 for a copy of our April number, and every stand was *completely sold out.* Yet, inquiry showed that these eleven newsstands had been furnished with 530 copies of our April issue!

* * *

The only way to be *sure* of your copy every month is to subscribe!

* * *

Those of our readers who have been brought up in a doctor's family are familiar with the practice of "G. P's" (Grateful Patients) of making gifts to the man who cured them of their ills. Happily for our Technical Editor, this custom is extending among the radio fans whose troubles he is similarly dissipating. To date the Technical Editor has received two crates of oranges, one box of grapefruit, one side of lamb, four automobile tires and so many cigars that he generously shares them with the Editor!

* * *

Few compliments have pleased us more than this one that comes from John Leuthold of Colorado; he writes:

"Always I am impressed with the dignity of the magazine—that something which takes radio science out of the realm of mere pastimes and fads and places it in the forefront of civilizing and world-advancing science."

* * *

With the single exception of Laurence M. Cockaday's article in our September issue on "How to Build the New Armstrong-Circuit Receiving Set," none of our "how to build" series has brought into the Editor's office the flood of letters as the same author's article in our January issue "How to Build a Real DX Regenerative Receiver." If anyone doubts the efficiency of this set—and occasionally a reader has had difficulty in getting it to operate—refer him to Byron L. Smith, of Spring Valley, N. Y., who writes:

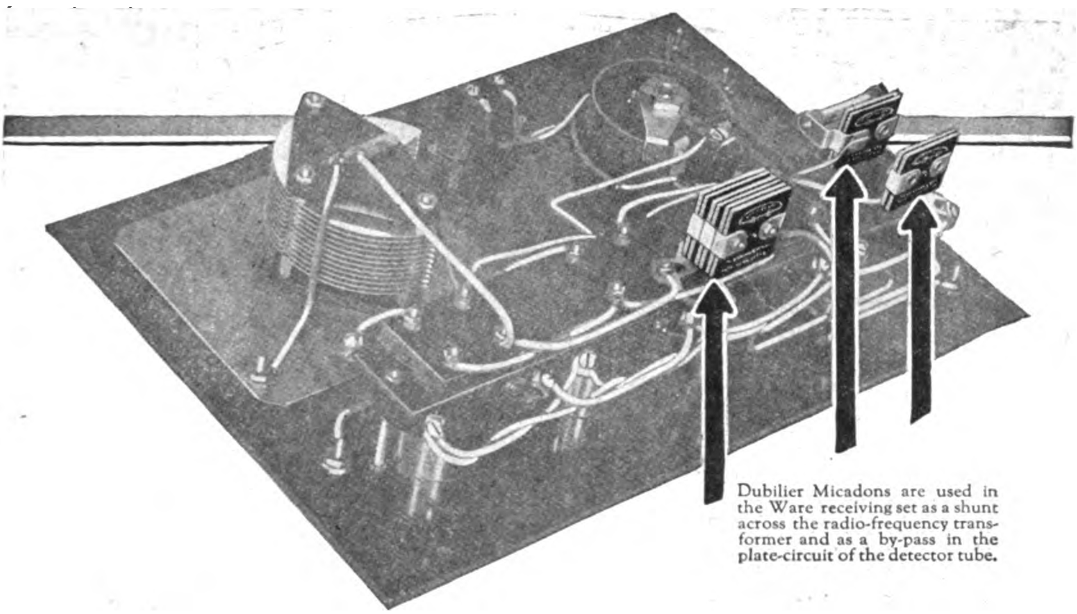
"I have constructed the DX receiver according to instructions in Popular Radio. The results I obtain from it are truly marvelous. . . . It is truly the set for the novice and for the DX bug alike."

* * *

If you see it in Popular Radio it's so!

Kendall Banning

Editor, **Popular Radio**



Dubilier Micadons are used in the Ware receiving set as a shunt across the radio-frequency transformer and as a by-pass in the plate-circuit of the detector tube.

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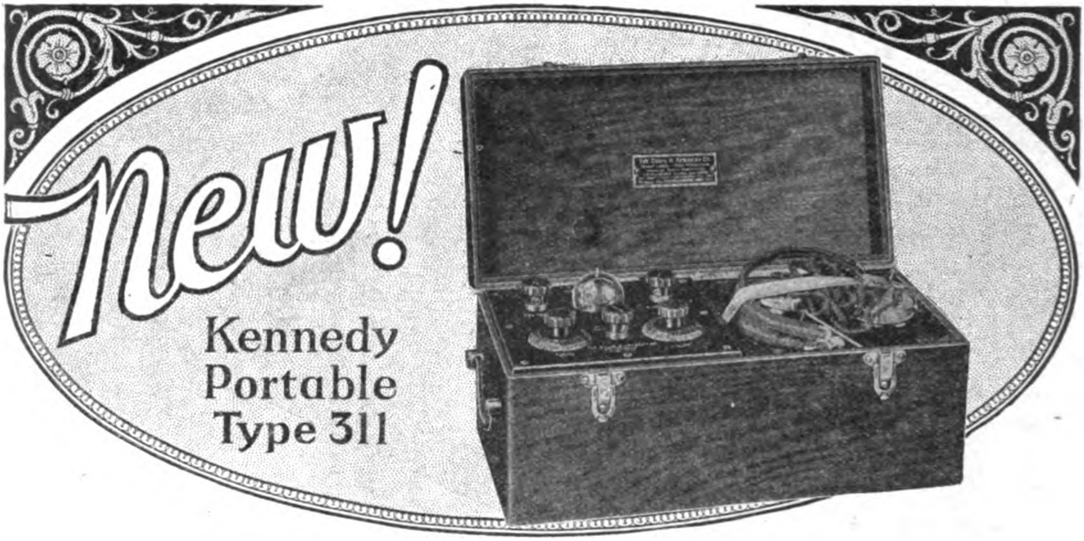
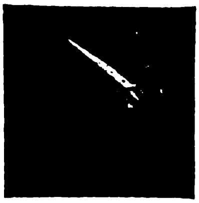


It's Ready—The Ideal Summer Set!

Enjoy Radio concerts at your summer cottage.



A welcome addition to the camper's kit.

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Here is the ideal Summer Radio Set! Just the thing to take with you on your vacation—auto touring, boating, camping, or to your summer cottage. A handy, compact set, so easily transported from place to place that you can take it with you wherever you go—yet so exquisitely finished that you will be glad to have it in your home.

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This new set is the latest triumph of the Kennedy Engineering staff. It has all the beauty, refinement and perfection of detail that distinguishes the Kennedy line and makes it the "Royalty of Radio." It is simple to operate, yet highly selective, with unusual freedom from interference—the ideal summer set.

No Storage Battery Needed

The Kennedy "Portable" is designed for use with any standard tube, including the dry-cell type. When dry-cell tube is used, the set is entirely self-contained, space being provided in the sturdy, beautiful oak cabinet for dry batteries and phones. Size 15x7½x7, weight 17 lbs. Complete, with tube, dry batteries and phones, **$75.00.**

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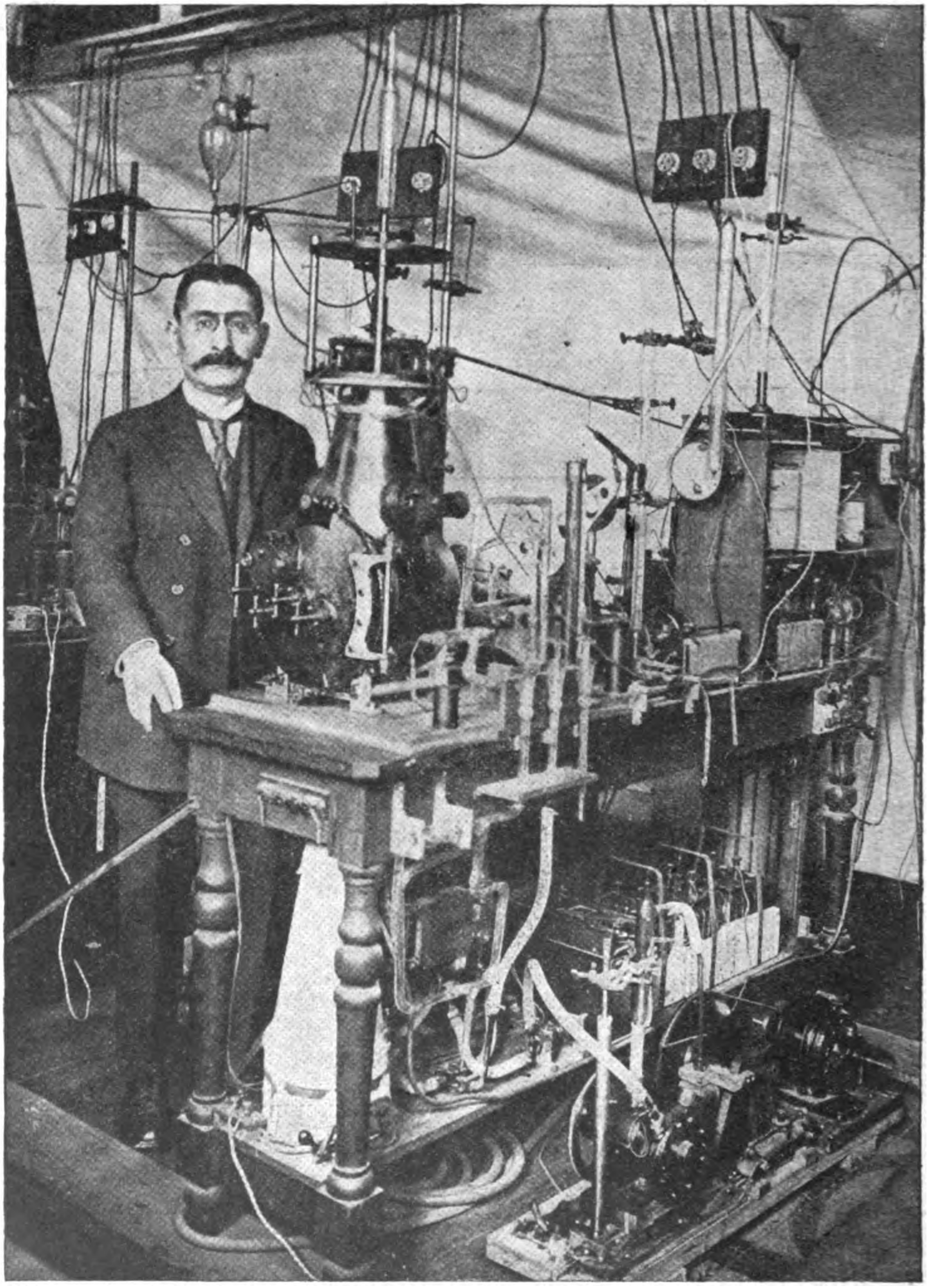


Dorien Leigh, London

The Most Sensitive Machine in the World for Recording High Frequency Currents

This complex device is the "cathode oscillograph," invented by the French scientist, M. Dufour. It is delicate enough and its action is speedy enough to picturize currents which oscillate at the rate of 1,000,000 vibrations a second. M. Dufour is professor of physics at the Faculty of Sciences in Paris. The machine will probably be used for receiving high-speed radio messages without the services of operators.

Popular Radio

VOLUME III JUNE, 1923 NUMBER 6

HOW TO USE YOUR RADIO SET ON YOUR VACATION

Don't Be Scared by the "Static" Bugaboo!

Much erroneous information has been circulated among novices in regard to that mysterious "static" that supposedly renders radio helpless in the summer months. The fact is that static is seldom strong enough seriously to interfere with the reception of radio signals even during the warm season; the only time that static really grows to a volume enough to curtail reception is when an electrical storm is passing through the immediate neighborhood. A great deal of enjoyment may be gotten out of a summer radio installation in the camp, on the automobile, on the farm, at the seaside or at any isolated place. The author has used radio in this way for summer after summer; from his practical experience this article has been written.—EDITOR.

By WILLIAM F. CROSBY

THIS is the time of year when the prudent radio man is making his plans for using his set on his vacation outings.

While there are many ways in which a radio receiving set may be used in the summer, the automobile trip or camping trip probably afford the best opportunities for getting practical service from it.

For this purpose the now familiar dry-cell tube comes to the rescue, by doing away altogether with the heavy and cumbersome storage battery. It is no longer much of a task to construct a set that may be easily transported by a vacation hiker in his blanket roll. In the past, a vacuum tube set has been quite out of the question; now, however, a small set may be made up that will weigh only a few pounds and that can be arranged in such a way as to be entirely self-contained, with all the apparatus and batteries within the cabinet.

When you plan to assemble your vacation set, don't make the mistake of buying low grade or cheap materials.

The average radio fan apparently does not notice the difference between the various makes of radio apparatus. If a dealer displays an article that is called by a familiar name but that costs less than the standard product, the chances are that the inexperienced fan will purchase the cheaper article. Here is often where his first mistake lies.

On the other hand the fan should not

be misled into believing that everything that is high-priced is therefore good.

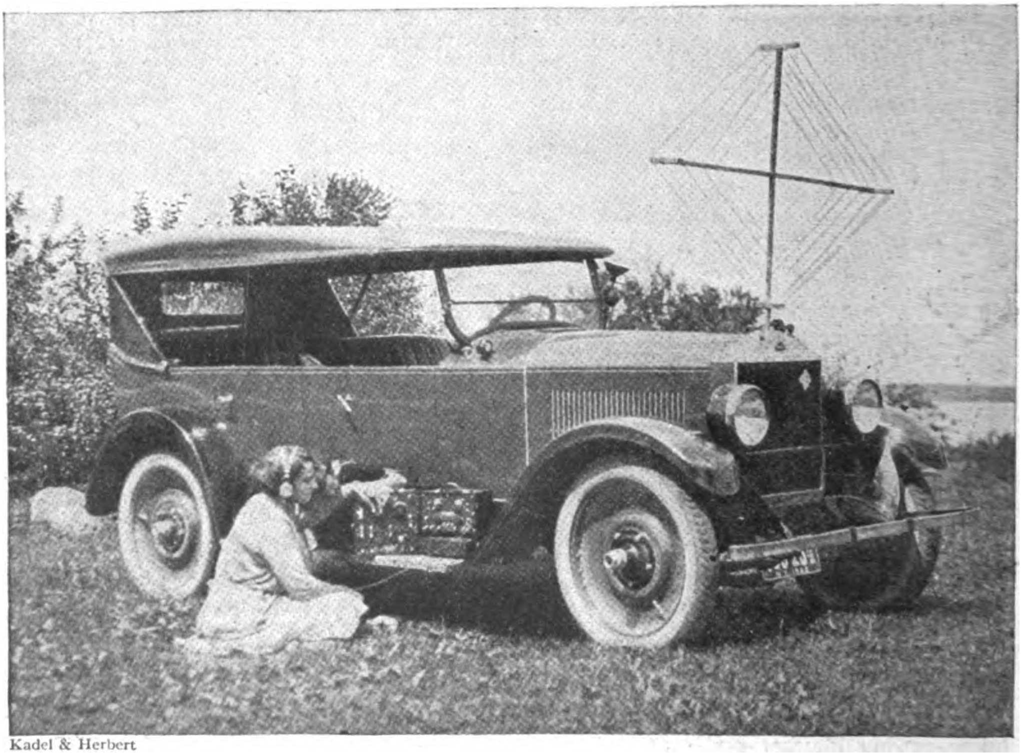
The best plan is to get acquainted with some radio man who has been in the game for a number of years, and get from him an authoritative list of materials needed, and the names of the various makes. This list may serve as the basis of the vacation set.

Do not be deceived by outward appearances of radio apparatus. "All that glitters is not gold"; sometimes the flashy piece of apparatus and the most highly polished set will prove to be far from satisfactory. Before you buy it, investigate carefully and find out if the set really works.

Last summer many camps were equipped with radio sets of all sorts and descriptions. Needless to say, the majority of them were simple crystal sets; consequently, the results, in a great many cases, were far from satisfactory. However, there are occasions when a crystal set can meet the campers' needs. This article describes both a set that makes use of a dry-cell and vacuum tube, and also one that uses a crystal detector. The circuits are almost identical. Excellent results should be obtained with the tube set, and good results from the crystal set, *provided* that a good piece of crystal is obtained. Success with a set of this kind depends upon the crystal; unless a good one is used, the set may just as well be left at home.

The circuit illustrated in Figure 1A shows an unusually simple crystal detector receiver.

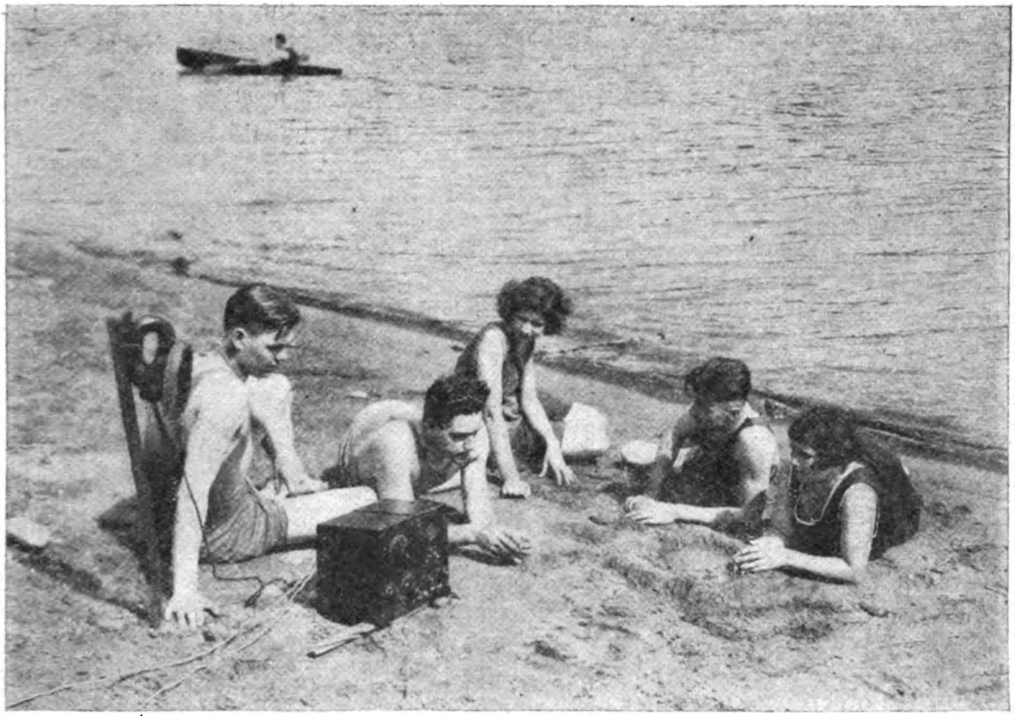
Figure 3A shows the same tuning circuit connected up with a vacuum tube detector. With the latter, it is recom-



Kadel & Herbert

RADIO BY THE ROADSIDE

Here is a radio frequency set installed on a pleasure car, with a loop antenna attached to the hood. This gives good results if it is carefully adjusted—but it is not as simple or easy to operate as the installation described elsewhere in this article.



Westinghouse

A CHURCH SERVICE ON THE BEACH

A couple of insulated wires thrown over the sands in place of an antenna and a ground, a portable set and a loudspeaker, furnishes a happy solution to the vacationist who wants to miss neither his Sunday devotions nor his morning dip.

mended that one of the dry-cell tubes be used, thereby eliminating the storage battery. If one of the regular six-volt tubes is used, no change will be required in the circuit, but a different type of socket will be necessary and, of course, the "A" battery will have to be of six volts, instead of one-and-one-half volts.

In Figure 1A, A represents an ordinary wooden variometer, B the crystal detector, C the head set, D the phone condenser and E a fixed condenser of about .0005 mfd. capacity.

Figure 1 gives a perspective view of the set as it should look when completed. The instruments should be mounted on a panel set into the front top of the cabinet, and a recess should be provided at the rear, so that the phones may be placed out of the way when the set is being carried or when it is not in use. Some hooks should be provided on the sides so that the cover of the set may be drawn down securely in order to make the box watertight against rainstorms; a strip of soft felt pasted on the edge of the lower lid will help to this end. Then by closing down the top tightly, the felt strip will be compressed and most of the dampness will be kept out.

There are many other little refinements that may be worked out. It may be possible, for example, to arrange the aerial and the ground wires on reels, such as are used for deep-sea fishing, and to have these reels screwed fast on the back of the box. Another item that should be included with the set is a good heavy strap for carrying it about. This may be arranged in such a way that it may be unstrapped and laid aside when the set is in actual operation; this strap should be made long enough so that the box may be slung over the back or carried from the shoulder.

In the vacuum tube set, designed for use when camping, the circuit will remain identical, with the exception that a tube will be used in place of the crystal detector.

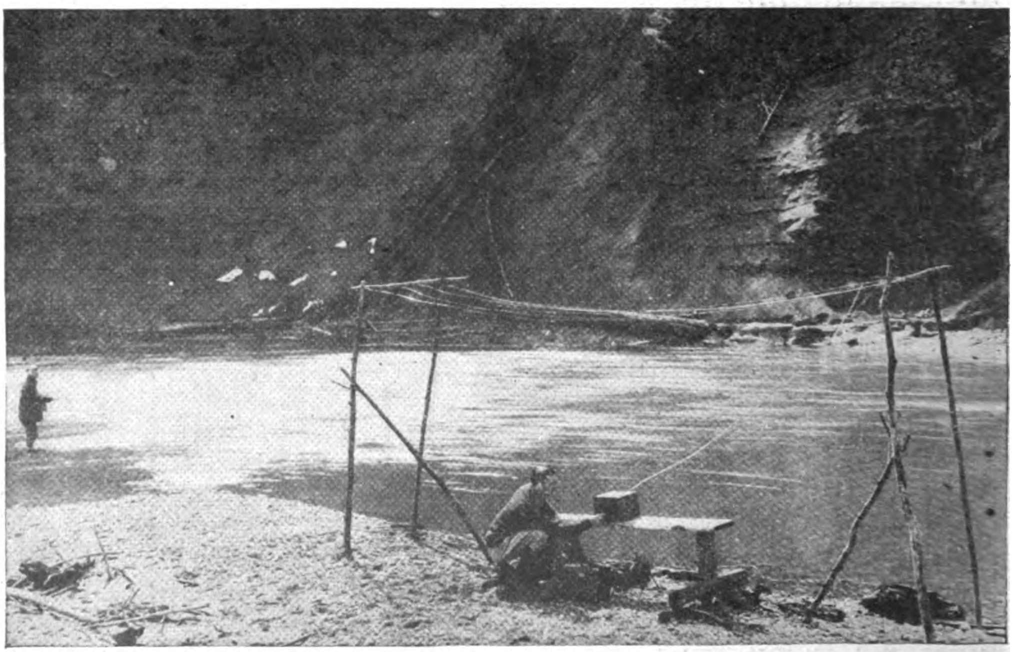
In Figure 3A it will be noticed that the letter A stands for the variometer; B, in this case, represents a small mica grid condenser and leak. The elements of the tube are shown by 1, 2 and 3; 1 being the grid, 2 the plate and the two figures 3 representing the two filament leads. The letter C refers to the head phones. D is the rheostat and E is the small .0005 mfd. fixed condenser. "A" is a dry-cell and "B" is a 22½-volt small-size battery.

Now for the arrangement of the set:

The over-all length will be governed entirely by the size of the variometer and the rheostat. This will also apply to the width. In order to keep the size as small as possible, the best arrangement will be to have the vacuum tube socket placed on top of the insulating panel that is used to mount the instruments upon. Figure 3 also gives an idea of just how the completed set should look.

By placing the vacuum tube on the top of the panel, it will be necessary to remove the tube itself every time the set is to be closed; for this purpose an opening should be left (at the back of the cabinet) large enough to take both the tube and the receivers. It will be advisable to keep the tube in the box in which it originally comes, as this is packed well; if the tube is placed inside as suggested, it will stand a lot of knocking around without becoming broken. In this case, however, in order to keep the phones from knocking about too much, a strap should be fastened inside of the box to hold them fixed in one position. It would be a good plan to do this in the case of the crystal detector set also.

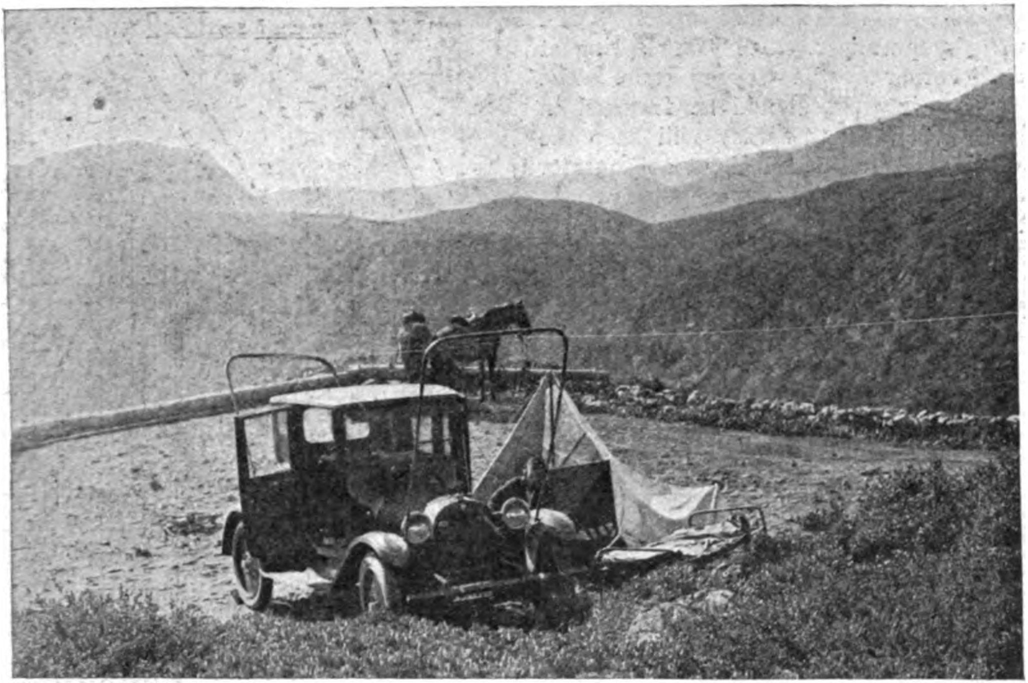
Before you buy or make the box, it



International

A RUSTIC ANTENNA ON A SALMON STREAM

On the banks of the Green River in Washington these anglers installed a receiving set that added immeasurably to their enjoyment of the evenings far up in the mountain country of the northwest.



Courtesy of "Radio"

TAPPING THE MOUNTAIN AIR FOR MUSIC

By means of a single-wire antenna attached to a nearby tree, these motorists are enabled to establish their camp as a receiving station within a few minutes, and where could a grander setting be found for the world's greatest symphonies than on the high spots of the world?

would be wise to obtain a dry battery, the "B" battery, the phones, and the case in which the vacuum tube comes, in order to design the set correctly and to provide room for every item. The batteries, both "A" and "B" may be arranged so that they lie in the bottom of the cabinet, one at each end. Of course, one of the small-sized "B" batteries should be used, in order to save as much space as possible.

The carrying strap and the felt waterproofing strip will also have to be taken care of in much the same manner as in the other set.

With a receiver of this kind, surprising results may be obtained if the set is properly made and properly operated. The operation is so exceptionally simple that there should be little trouble on that score, but the making of the set requires real care and thought.

Use insulated wire and be sure to solder all connections.

Remember that when a piece of metal (such as a binding post or switch arm) is left out in the open, as often happens with a set of this kind, it will corrode or become oxidized. When that happens the operator soon realizes that the signals have faded out, and for no apparent reason. It might be well therefore, to use a plug and jack system for the telephones on the vacuum set particularly.

At this point it would be well to point out that the dry-cell tube is just as good as any other when it is used as a detector; it is also good as an amplifier. If it is used in this latter capacity, it will be necessary to have it suspended on springs, on account of microphonic noises in the tube itself. This is accomplished by mounting the sockets on a piece of wood or other material, and then by putting a small brass spring at each corner of the wooden strip. The springs, in turn, should be fastened in such a manner that they will keep the wood piece suspended about one quarter of an inch clear of everything else in the set.

It is possible to work out for this set a two-stage amplifier that will fit into the opening where the receivers and the tubes are normally stowed; in such a case there will be no place for the other parts unless a separate box is made. A two-stage amplifier of this sort was made recently that took up a space of only four inches by eight inches. The tubes were mounted on the top and the transformers on the bottom, while the single rheostat that controlled both of the tubes was placed in such a way that it came directly between the two sockets. Jacks were arranged across the end of the panel to take care of the detector, the first stage and finally both stages and the detector.

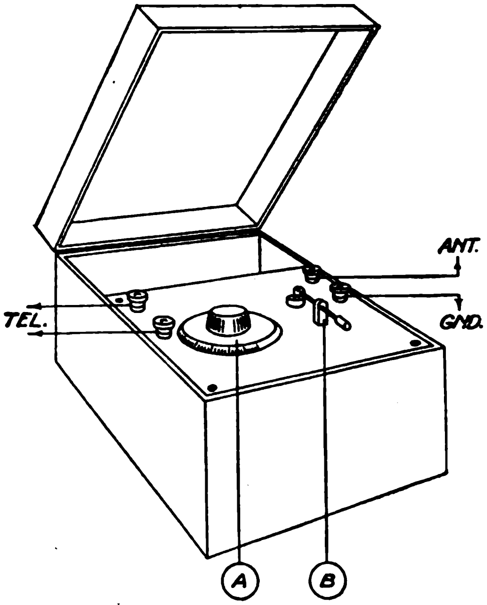


FIGURE 1

Keystone View Co.

BE SURE THAT THE CONNECTIONS ARE FASTENED TIGHT!

And be sure to remove the tubes from the sockets while the car is traveling, in order to avoid breakage.

A simple radio set to be used in an automobile presents problems that are not so easy to solve. In the first place it is hardly worth while to build a set that will operate while the auto is in motion. If this is done radio frequency amplifiers will be needed, and the cost will mount into considerable money; besides, there will also be the added drain on the storage battery and the large size of the set itself.

On the other hand a small, compact set may be built that will work well from the storage battery of the car, and it may be used whenever the car is standing still—such as at the bathing beach or on a camping trip.

The circuit chosen is one of the

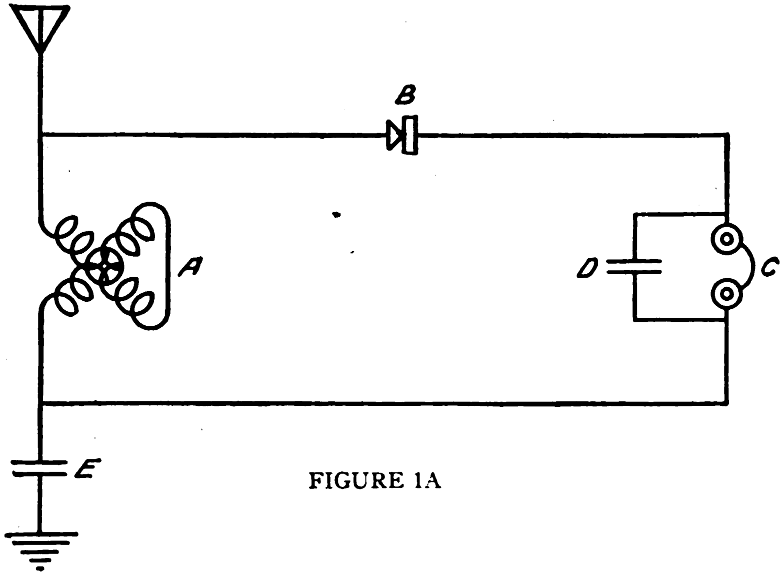


FIGURE 1A

A PRACTICAL RECEIVER AND HOOK-UP FOR A MOTOR CAR

FIGURE 1 *(at the left) shows the outside of the crystal set, and* FIGURE 1A *(above) shows how to connect A, the variometer; B, the crystal detector; C, the telephones; D, the telephone fixed condenser and E, the fixed condenser in the ground lead.*

simplest for the purpose and if operated correctly, all sorts of long-distance stations should be received in good style.

The circuit shown in Figure 4A is the so-called "single-circuit set" which is not recommended for crowded areas on account of the fact that it will also act as a transmitter.

The circuit for the car is a little more expensive to make than the others that are here described, but the results compensate for the added cost.

Figure 4A shows the actual wiring diagram of this type of receiver. A is the stator of the variocoupler; B is the rotor of the same instrument; the grid leak and the condenser are shown at C, and D is the vacuum tube; E is the headphones; F is a 43-plate variable condenser.

Note that in both Figures 3A and 4A, as in nearly all vacuum tube circuits, there is a common terminal on one leg of the "A" battery and one leg of the "B" battery. This connection is run across from the negative lead of the "A" battery to the negative side of the "B" battery. Care must be exercised to see that the "A" and "B" batteries do not become connected in the wrong places, because if the "B" battery current happens to get into the filament circuit, the builder of the set will have to make a trip to the nearest radio store to purchase a new vacuum tube. The filament will burn out almost instantly.

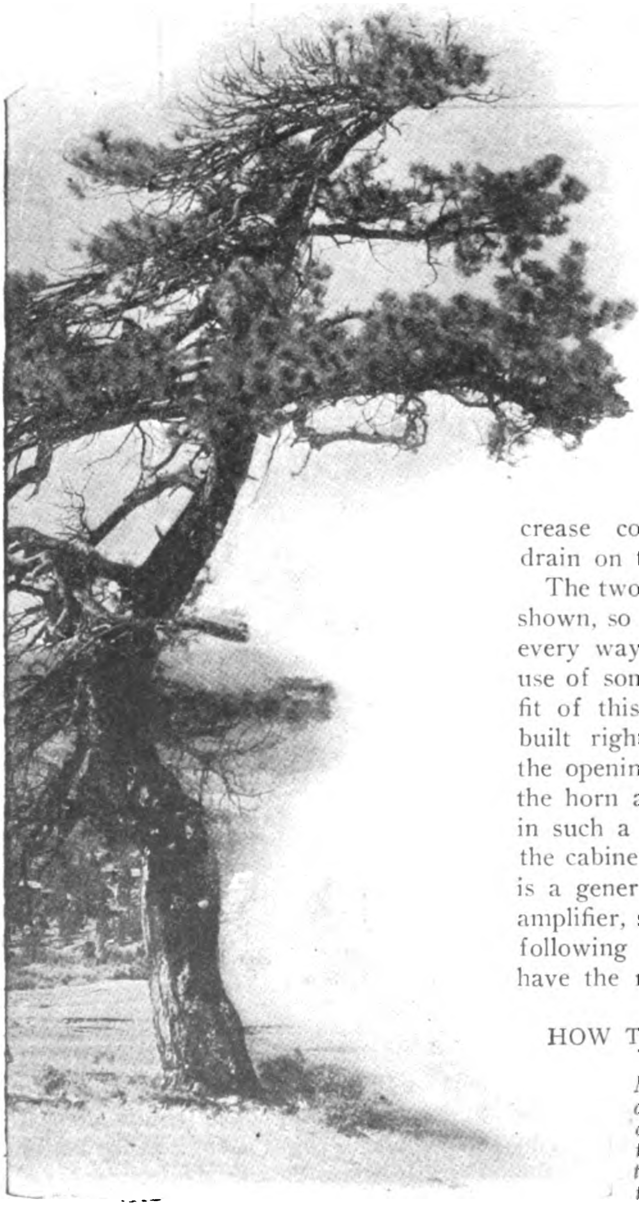
Notice that the diagram provides for a cabinet or box similar to the one used in the other sets. An opening is left in one end so that the tubes and the headphones may be easily transported without risk of breakage. It is not well to leave the tubes in the sockets, as the vibration of the automobile is liable gradually to work them loose, in which case they may become broken.

Figure 4 also gives a good idea of what the completed set should look like. The coupler is placed on the left-hand side of the cabinet, with the switch lever and switch points above it and the variable condenser on the right at the bottom. Directly above the variable condenser the rheostat knob will show and the tube and socket will be placed behind this instrument. The cabinet is a little different from the others suggested, in that it has a front that drops down to form a sort of desk for the operator. There should also be a small hinged door at the top so that the tube may easily be removed from its socket. The "B" battery may be secured in place inside of the cabinet in back of the variable condenser or the coupler. The panel itself will have to be recessed back a little from the front of the cabinet so that the front may be closed up without interfering with the protruding knobs.

A set of this kind, if it uses a six-volt tube, may be connected directly to the storage battery of the car. It is suggested that the radio man have a mechanic install on the dash two binding posts that are at all times connected to the six-volt car battery circuit. This will make it a very simple matter simply to clip the battery leads on these binding posts at any time to connect up the set for use.

If required, a two-stage amplifier may also be added to the set. If this is done, the size will increase considerably and likewise the drain on the storage battery.

The two-stage amplifier hook-up is also shown, so that the set may be complete in every way. It is also possible to make use of some sort of a horn with an outfit of this kind. Such a horn may be built right into the cabinet with only the opening showing. In order to have the horn as long as possible, arrange it in such a way that it lies lengthwise in the cabinet, as shown in Figure 5. This is a general plan view of the two-stage amplifier, showing the horn in place. By following this plan it will be possible to have the receiver on the outside of the



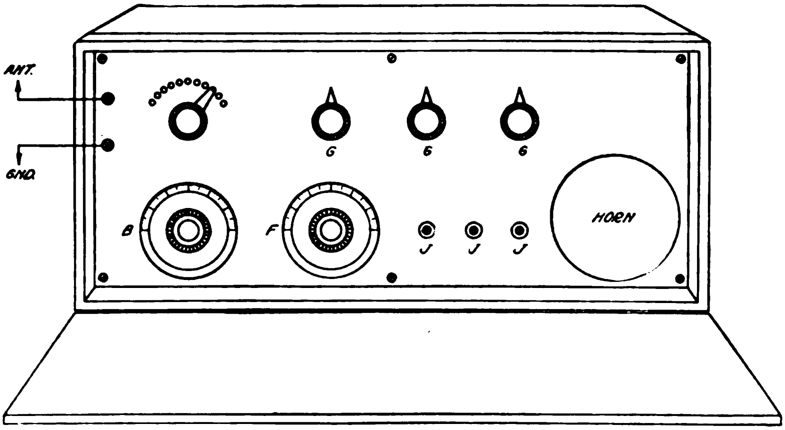
Brown Brothers

HOW TO PUT UP YOUR ANTENNA WIRE IN THE WOODS

Merely attach a weight to the end of a fishline, throw it over the limb of a tree, and pull up the wire attached to the other end of it. To take it down, detach the weight and the wire may be pulled back and wound up again.

FIGURE 2

The makeup for a complete set with two stages of amplification and a loudspeaker, all in one cabinet. The component parts of this set are the same as shown in Figures 4, 4A, 5, and 5A.



cabinet where it is easily accessible; the adjustment of the pressure on the receiver is sometimes necessary in order to get the best tone and the clearest music. A half turn one way or the other on the set-screw may make a great deal of difference in the quality of the received signals.

Needless to say, the two-stage amplifier (as shown in Figures 5 and 5A) may be run from the same car storage battery.

If the best results are expected of this amplifier, be sure to solder all connections. Do a neat wiring job and keep the wires separated a respectable distance away from each other.

Be sure to turn the two transformers at right angles to each other so that there will be no chance for howling.

Connect the terminal marked S-1 (or sometimes marked G) to the grid of the tube, and remember that this is the most important lead in the whole set. Keep it as short as possible and be sure it is well soldered.

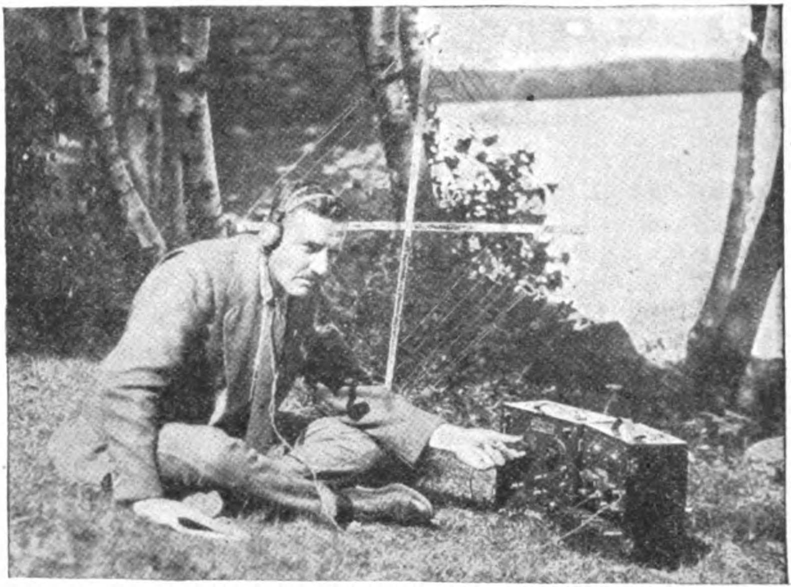
Figure 2 is a view of a completed set with two-stage amplifier and loud speaker built all in one.

The aerial is an important part of the outfit, but it is easy to erect. No elaborate system is needed; a single wire from fifty to one hundred feet in length will be sufficient for all receiving work.

In order to place the aerial at a suitable height, it should be strung up to some nearby tree or fence. Care should be used that there are no power wires along one side of the road, at least, and it will be well to give them a wide berth, as sometimes they carry rather high voltages.

Keep the aerial away from power lines and thus avoid serious accidents.

Here is a simple scheme for raising



Kadel & Herbert

A COMPACT SET FOR THE CAMPER

The radio frequency loop set as shown on page 408 is equally serviceable in the woods. In case an ordinary antenna is used (as shown on page 410) a large stone attached to a ground wire and dropped into the water furnishes excellent grounding.

an aerial well off the ground without the necessity of climbing up a tree or pole; select a good length of fairly heavy fishline, with a sinker on one end of it. Pick out some tall object, such as a tree, and fling the weight with the fishline attached to it over one end of the branches. To the other end of the fishline attach a small porcelain insulator, and to this connect one end of the wire.

Haul up on the other end of the fishline and pull the aerial well up into the tree. The lower end of the aerial should be connected direct to the binding post on the receiving set, but some sort of a strain insulator of light weight should be attached to the car so that there is no pull exerted directly on the set.

To take the aerial down, merely untie the sinker; the fishline will then run freely through the branches of the tree and may be wound up, together with the wire from the aerial.

This arrangement may be used with any of the sets described in this article; in the last named set (if the two stage amplifier is used) signals may be heard by simply erecting a small aerial to run over the top of the car and down to the radiator cap. The results will not be as

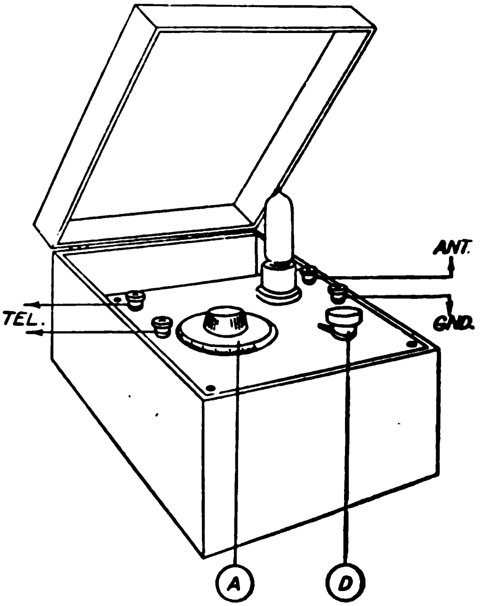


FIGURE 3

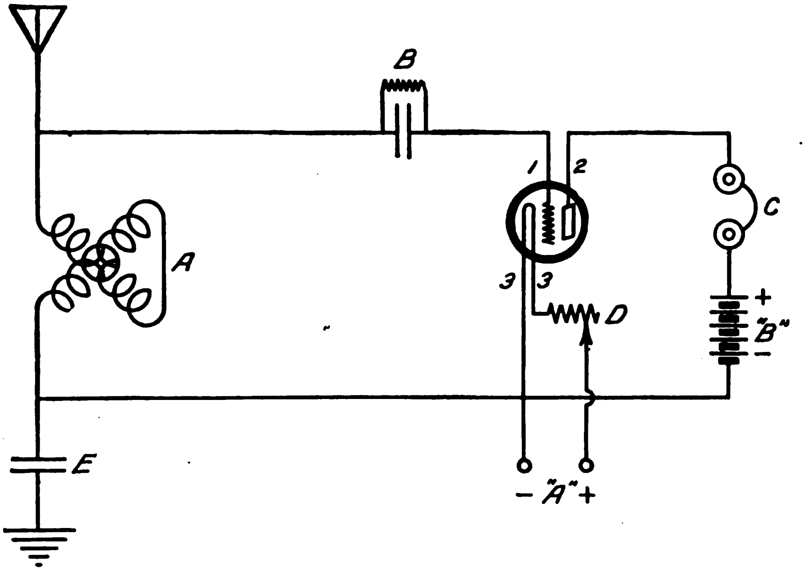
good, however, and the other type of aerial is recommended.

If there are no trees at hand (such as at a beach) a wire suspended a few feet above the sand may give fairly good results. If the wire is strung at the same height as the top of the car it will clear the head of anyone who may walk under it. Usually there is a piece of driftwood handy; this may be stuck in the sand and made to serve as a support. But almost any wooden object will serve, so long as the wire is kept insulated from the ground itself.

For the ground connection it is possible to use the metal frame of the car as a "counterpoise" ground. This, however, is not always satisfactory, and it is wiser to provide a sharply-pointed iron or brass rod, that may be driven into nearby moist ground. The deeper the rod goes into the moisture the better will be the ground; a piece eighteen inches long should be sufficient. An ordinary ground clamp or a binding post may be affixed to the upper end of it, and the ground wire from the set may be connected to this.

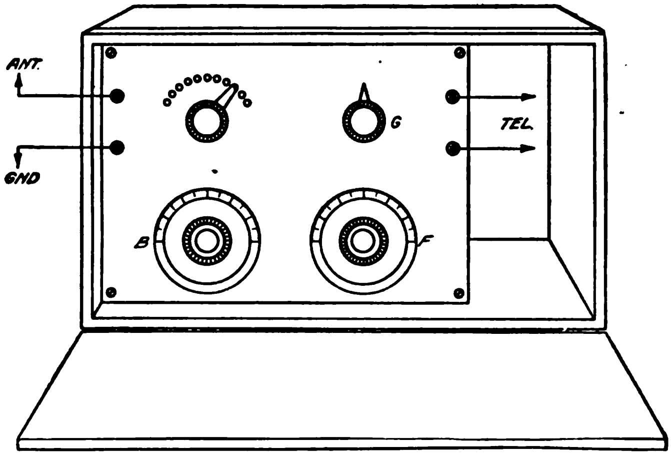
Do not let the bugbear of "summer radio" idleness stand in your way. Take a set with you to the beaches, to the mountains or wherever you intend to spend your vacation. A small portable set may even be made to take away on week-end trips. The pleasure of a picnic supper in the mountains to the strain of the latest music from the city will be a pleasure not soon forgotten.

A later article will describe in detail how to install a radio set in the cabin or on the deck of your motor boat or cruiser or in your canoe, and how to make general use of it during the summer months; it will show how to install the aerial and ground systems and also point out the best types of sets to use and tell why.



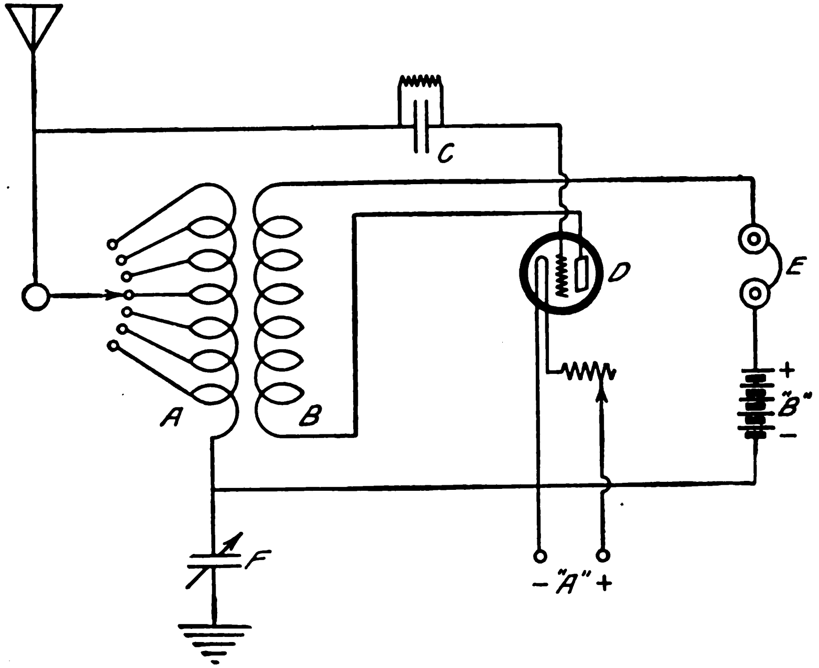
THE CABINET AND HOOK-UP FOR THE PORTABLE TUBE RECEIVER

Figure 3 *(at the left) shows the outward appearance of the set, and* Figure 3A *(above) shows the electrical connections for: A, the variometer; B, the condenser; and grid leak; C, the telephones; D, the rheostat, and E, the ground fixed condenser. "A" is a 1½-volt dry-cell and "B" is a small size 22½-volt battery. The numerals 1 and 2, refer to the grid and plate of the tube respectively, and the two "3's" are the filament wires.*



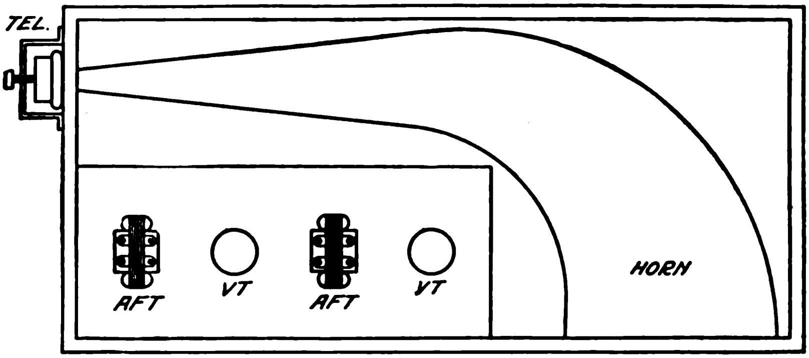
THE CABINET FOR THE AUTOMOBILE RECEIVING SET

FIGURE 4. *This set is larger and also more efficient than the set shown in Figures 3 and 3A. It would be rather bulky to carry around on a hiker's trip, but is well adapted for installation on a motor car.*



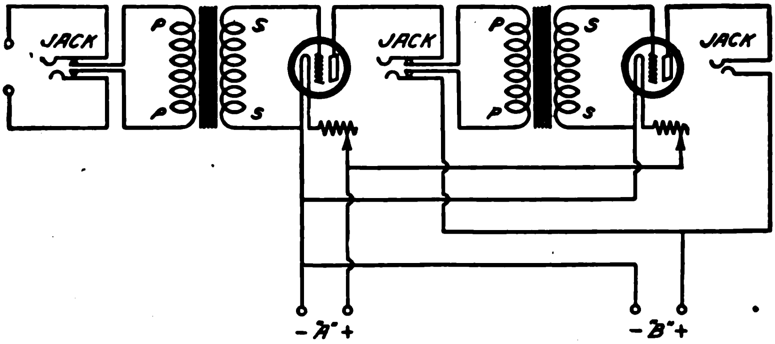
THE HOOK-UP FOR THE AUTOMOBILE SET

FIGURE 4A. *The parts are: A, the primary of the variocoupler; B, the secondary; C, the condenser and grid leak; D, the vacuum tube; E, the telephones and F, the variable condenser. "A" may be the storage battery of the car and "B" is a 22½-volt battery.*



THE TWO-STAGE AMPLIFIER FOR USE WITH THE AUTOMOBILE SET

FIGURE 5: *This diagram is a plan view of a two-stage amplifier that may be made to use with the set shown in Figure 4, or it may be incorporated with the other set into a single set, as shown in Figure 2. The horn is built right into the cabinet.*



THE CIRCUIT DIAGRAM OF THE AMPLIFIER

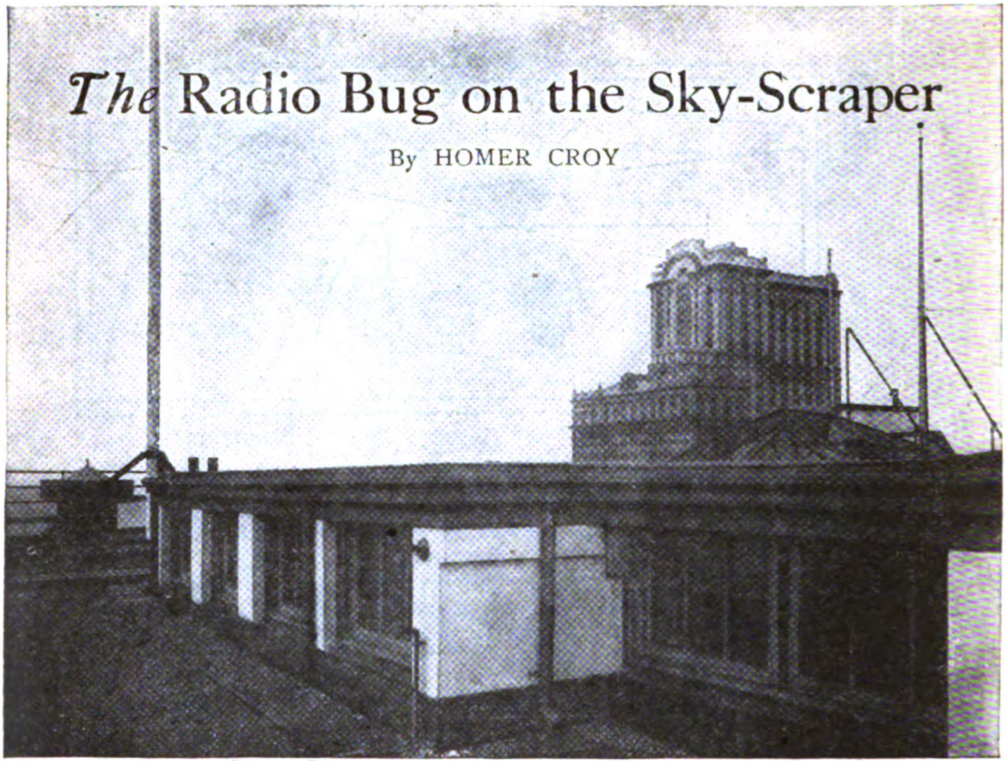
FIGURE 5A. *Showing connections for the jacks, the tubes, the transformers and the rheostats.*

Westinghouse

¶ *In the next issue of* POPULAR RADIO *the author will tell how to install a receiving set on your canoe, rowboat, launch or yacht.*

The Radio Bug on the Sky-Scraper

By HOMER CROY



From a photograph made for POPULAR RADIO

¶ *The True Story of a Big Business Man Who Is Making Come True a Modern Arabian Nights Dream of His Boyhood*

AT 24 State Street, New York, is a skyscraper, and on top of the skyscraper is a radio bug. He is a very unusual and a very different bug.

The story began a number of years ago in Columbus, Ohio, where a poor boy was selling newspapers. The boy had to hump himself from early morning until time to fall into bed. This is not so wonderful in itself, as thousands of poor boys have gone into the world with a bundle of papers under their arms. It was the recognized way to get to the top. In fact, if a person rose to prominence without having sold papers in his early days he was ashamed of it. He was afraid people would think that he didn't amount to much. But this boy, whooping it up on a corner, was unusual; he loved music.

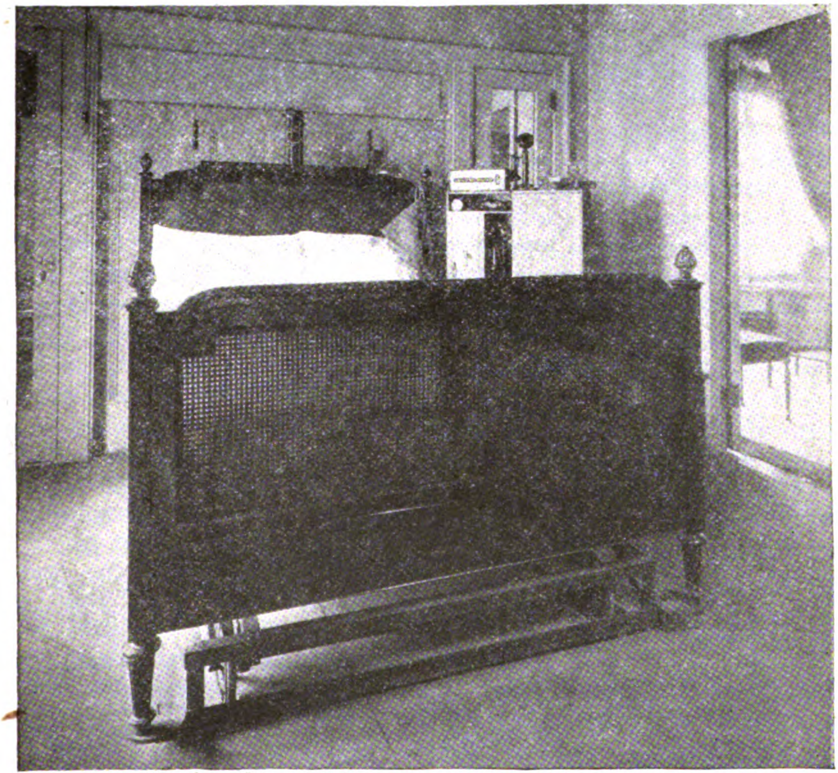
The boy became a man, the man became a financier and the financier became busier than ever. The passion for music still slumbered in his soul, but there was no time to satisfy it. Instead he became busier and busier, for now the exnewsboy was operating in Wall Street and was a Power—none other than Henry L. Doherty of business fame.

In many cities of the United States every wheel that turned, every light that burned, paid its tribute to his genius. He was banker, oil operator, engineer, inventor and so on down the list—and all the time the germ of his love for music was softly swishing around in the depths of his subconsciousness. He had made his pile and yet he hadn't been able to appease his passion. Something was still gnawing, gnawing. . . .

He became busier and busier, and Big Business became a millstone around his neck. He dared not go off and leave it; if he did a power plant was certain to break down and two hundred thousand people with candles would be going around cursing in the dark. He could not leave business to go into the country to build himself a home, so he bought the roof of a skyscraper and there built himself a "bungalow." (That is what he called it, but to a humble writer it looked like a mansion.) There it was up among the flagstaffs, overlooking New York harbor, with something like a dozen rooms. And a bachelor! A colored maid met me at the door and led me down a long hall lined with old and rare prints of early New York and deposited me in the reception room; in a moment a colored man, looking like a Pullman porter, appeared with something to smoke. I began to nose around.

Rooms. All kinds of rooms. A gymnasium; a squash court, a handball court, billiard room, chemistry laboratory, and a solarium, as well as plain, everyday, ordinary rooms; a whole string of them. The fire laws were such that a wooden structure could not be used and as a result it was made out of steel and stucco. The "bungalow" was only a few blocks from his office at 60 Wall Street so that he could dodge back and forth without loss of time—as quickly as the average man could get to the subway.

At last Henry L. Doherty could have whatever he wanted. He could build his dream house. Expense was to be spared in no way. What did he get? The germ of his youth had been gnawing—and the first thing he put in was an aerial. It was installed long before the radio craze swept the country. Why did he



From a photograph made for POPULAR RADIO

THE MAGIC BED WITH ITS RADIO ATTACHMENT

By merely pressing a button electrically-operated doors open and the bed with its occupant rolls out under the stars and listens in upon the world of the ether.

From a photograph made for POPULAR RADIO

A SYMPHONY CONCERT SERVED ON A BREAKFAST WAGON

Unable to shake off the business cares of Wall Street early enough to enable him to attend musical entertainments, Mahomet Henry L. Doherty summons mountain music to him.

want it? Not for weather reports, not for lectures on how to brush your teeth without any of the bristles coming out; the Man in the Moon did not interest him. He wanted music. He could have had a dozen seats at the Symphony if he had wanted them, but he was too tired; any minute something might go wrong with one of his companies, and he must be on the job. So he went to radio. Lead-in wires he had all over the place. When he was resting in the solarium he did not want to trot into the sitting-room to find out what the ether had to offer. He could plug in almost any place and hear what was going on. His receiving set was mounted on a breakfast-wagon and softly it moved on wheels of rubber. In whatever part of the house he was, he simply touched a button and his man in the white coat came trundling in the mobile receiving set; and then in his sun parlor, or on his open air balcony, up among the stars, he leaned back in comfort and hitched onto the ether. There among the clouds the ambitions of his boyhood were realized.

A singer who was a great favorite of his was Frances Paperte. She was the wife of one of his office managers. Long had he been trying to get to the opera to hear her, but always was Business about his neck. And then one evening Frances Paperte was asked to go to one of the sending stations to entertain and at that hour Henry L. Doherty put everything else aside and for the first time in months was able to hear her sing.

His enthusiasm did not stop here. He had a most amazing bedroom, a bedroom which would make the Begum of Bhopal stare and stutter. It was an electric bedroom. In fact, there were three rooms lined up in a row and a most marvelous contraption they were. One was a dressing room and there in the warmth he climbed into his pajamas and piled into bed. He pushed a button and electric doors opened; he pushed another button and lo! the bed began to move. It was mounted on a track and out of the room it shot. In the next room, which was a sleeping porch, it stopped and waited to see what he wanted. If it was a clear night and the stars were overhead, he touched another button; more electric doors opened and out he shot under the Pleiades. His portable receiving set was beside him and there lying in bed on the roof of a skyscraper the dream of his boyhood was realized. A big mahogany cabinet was fastened to the sides of his bed by a swinging arm. Here were telephones, call buttons, buzzers and a writing desk so that if at any time during the night he woke up with an idea he could slap it down on paper. When the radio concert was over, he took the receivers off his ears, turned over—and another day was done. The dream of his boyhood was realized.

On the wall of the reception room was something that struck me. It seemed almost prophetic—so closely did it seem to link the past with the present. It was a framed photo of Longfellow, for Henry L. Doherty was a great lover of poetry. Set in the frame was an autographed letter by Longfellow, and underneath it, all in the same frame, were Mr. Doherty's two favorite stanzas. The picture had been his many years and was just as he had moved it to his new home. The second stanza was:

And the night shall be filled with music
  And the cares that infest the day
Shall fold their tents, like the Arabs,
  And as silently steal away.

Thus when the day was done, and the darkness fell from the wings of night, up there among the clouds, the night for Henry L. Doherty was filled with music. The thing which he had admired from youth and which he had carried with him for years, was now a reality. The music which he could not afford to go to now came to him.

But to Henry L. Doherty music, entertainment, was not radio's all.

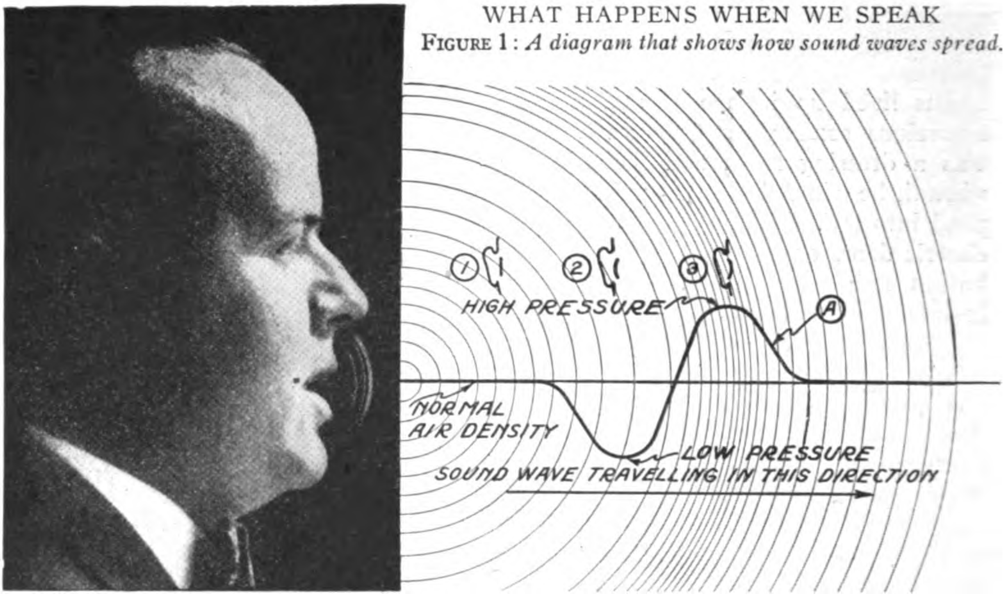
"What," I asked him, "do you think of radio?"

"We are just entering the door," he said. "I see such a wonderful era ahead for it that we are going to employ it commercially. We spend $13,000 a month on telegraph bills. That is too much. We are going to change all that and use radio. But with us that is only the beginning. Through the central part of Ohio we run all the traction lines, light the cities and furnish the power for the machinery in the manufacturing plants—such cities as Warren, Lorain, Ashland, Mansfield, Masillon, and Alliance. At any moment something may go wrong with one of our power plants. Practically every wheel in these cities would stop. We have been depending on the telephone lines for communication, but at the very moment that we need the lines most they are out of commission—possibly from a heavy sleet storm. Our power lines are up on high steel cables and underneath are the telephone lines, spanning miles and miles. If one of the big power wires breaks it paralyzes the telephone. We are now drawing up plans to use our big power wires to talk over—line radio, you know, wired wireless. In a few months we expect to be running interurban cars, power machinery, electric lights and at the same time be talking over the same wires. Then if in a sleet storm one of the power wires breaks down, radio will leap the gap in the wire and go on—communication will be kept open. That is how much I think of radio."

It makes one gasp. Truly enough, we *are* just at the door. The Radio Age is upon us.

WHAT HAPPENS WHEN WE SPEAK

FIGURE 1: *A diagram that shows how sound waves spread.*



How the Microphone Transmitter Works

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 10

"Do you know what sound is?"

"Do you know how and why you hear sounds?"

"Do you know how the microphone changes sound waves into electric currents?"

Until you can answer all of these questions you cannot have a clear understanding of radio telephony. This article answers them.

By LAURENCE M. COCKADAY, R.E.

"SOUND" exists only in our brains. We ordinarily say that sound "travels." It does not. Indeed, it does not exist at all outside of our brain, for sound is merely a record on our brain produced by a sound "wave."

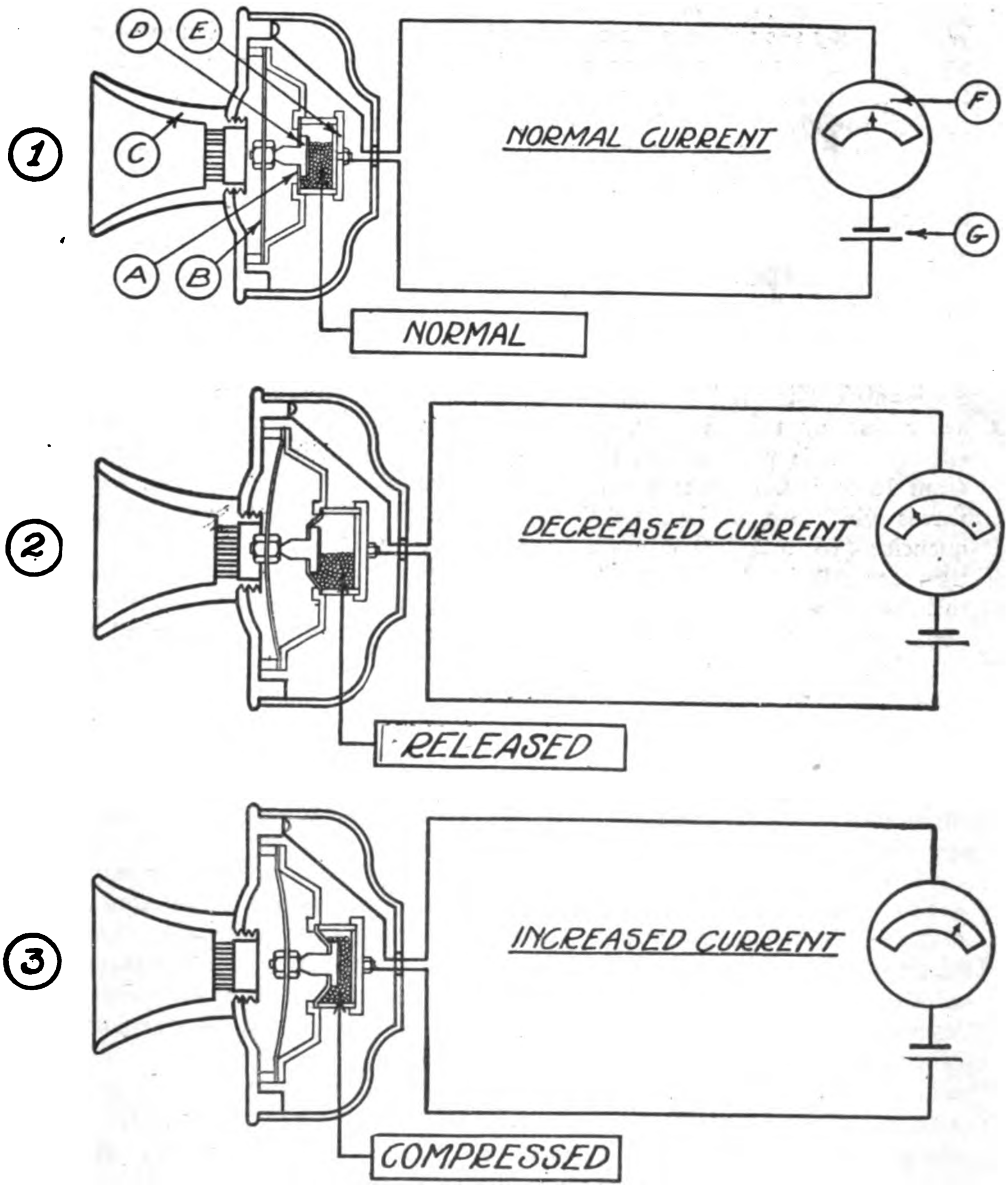
If there were no human beings on earth, there would be no sounds on the earth—for there would be no brains upon which the sound waves could make a record. Sound waves might be created, but no sounds would be recorded.

What, then, is a sound wave?

First of all, we are sure that a sound wave is not a wave of sound, inasmuch as sound does not exist outside of the living body. From its very name we learn that it is a wave—a wave that makes a record on our brain. But what kind of a wave? A wave in what? Here we have a clue.

Sound waves are waves in air. We are sure of this because sound waves will not pass through a vacuum. They must have some sort of a gas (such as air) through which to travel.

The earth is covered with a blanket of air which at any certain point has a fairly constant density; the molecules of air are fairly evenly spaced, in other words.



HOW THE ELECTRIC CURRENT THAT FLOWS THROUGH A MICROPHONE VARIES WITH THE SOUND WAVES IMPRESSED ON THE DIAPHRAGM

FIGURE 2: *A microphone consists of a collector horn (C) and a diaphragm (B), to which is attached a plunger contact (D); this passes through a flexible insulating disc (A), which forms one end of a cylinder (E), which contains the carbon grains—all of which are shown in (1), above. A current from a battery (G) passes through the circuit, which includes the carbon grains; this current is registered on a meter (F). When the diaphragm is vibrated, first on one side and then on the other, by sound waves [as shown in (2) and (3)], the carbon grains are released and compressed, respectively, and a smaller or greater amount of current flows through the microphone. This variation of the strength of the current that flows through the microphone is directly in proportion to the strength of the sound waves which come from the voice or the musical instrument, and which are impinged against the diaphragm.*

When Milady sits at the opera on a warm evening, she languidly passes a beautifully feathered fan before her face. Little thought she gives to the fact that she is producing a "wave in the air," or in other words, an "air wave." But she is. In one sweep of the fan the molecules of air are crowded together in front of the fan and spread far apart in the region in back of the fan. A wave is produced; it strikes her face; she feels it.

This wave is exactly like a sound wave, except that it is produced about once in every one or two seconds, whereas a sound wave is produced at the rate of from 16 to 20,000 times a second. Air waves which are produced at these frequencies (16 to 20,000 waves a second) then, are called "sound waves." We call them sound waves because the human ear responds only to air waves of these frequencies. We say we cannot hear some sounds because they are too low or too high in pitch.

A sound wave, therefore, is an air wave of a frequency that can be picked up by the ear and that will produce sound records on the brain.

How do we hear sounds?

Science tells us, in the study of anatomy and physiology, that the ear consists of an outer sounding-board, or reflector, which concentrates the sound waves and leads them into a tubular passageway to a thin stretched diaphragm called the ear-drum. This ear-drum vibrates in time with the sound wave impressed upon it and produces a nerve impulse (something like an electric current) which travels along the "hearing" nerves up to the brain, where it is recorded directly on the brain. This brain record *is* sound. It will be seen that the sound wave does not travel to the brain, but it is converted into an impulse by the ear, which *does* travel to the brain.

If we study the diagram in Figure 1 we will understand how the ear vibrates in time with the sound waves which pass by it.

Here we have a picture of a man with his mouth open and producing one single air wave or sound wave. Before the man spoke the air density in his vicinity was even; the air molecules were undisturbed. This could be illustrated by drawing lines in front of him with equal spacing, showing an equal spacing of the air molecules. However, when he speaks and a sound wave issues from his mouth in ever-widening circles, the air molecules are displaced.

If we could automatically stop a sound wave and make it visible so that we could examine it, it would look something like that shown in the diagram. A human ear in the portion of the wave shown at 1, would be in a region of normal air density as shown by the curve A drawn on the diagram and therefore the ear-drum would be in a normal position, as shown, giving a normal impulse to the brain. In this position of the ear-drum we hear nothing, as the brain records only *variations* of the strength of nerve impulses.

If the ear were in the position 2 (in relation to this stationary wave), it would be in a region of low air density or low pressure (see the curve A at this point), and the ear-drum would curve outward on account of the partial vacuum outside of the ear. This would produce a lesser nerve impulse to be transmitted to the brain.

If the ear were in the position 3, it would be in a region of high air density or high pressure (see curve A at this point) and the ear-drum would curve inward on account of the pressure outside of the ear, and a greater nerve impulse would be transmitted to the brain. Thus "sounds" or records of sound waves are produced in the brain which have the same frequency as the original air waves that pass the ear.

The ear, then, changes sound waves into nerve impulses which have the same time and energy characteristics as the sound waves themselves.

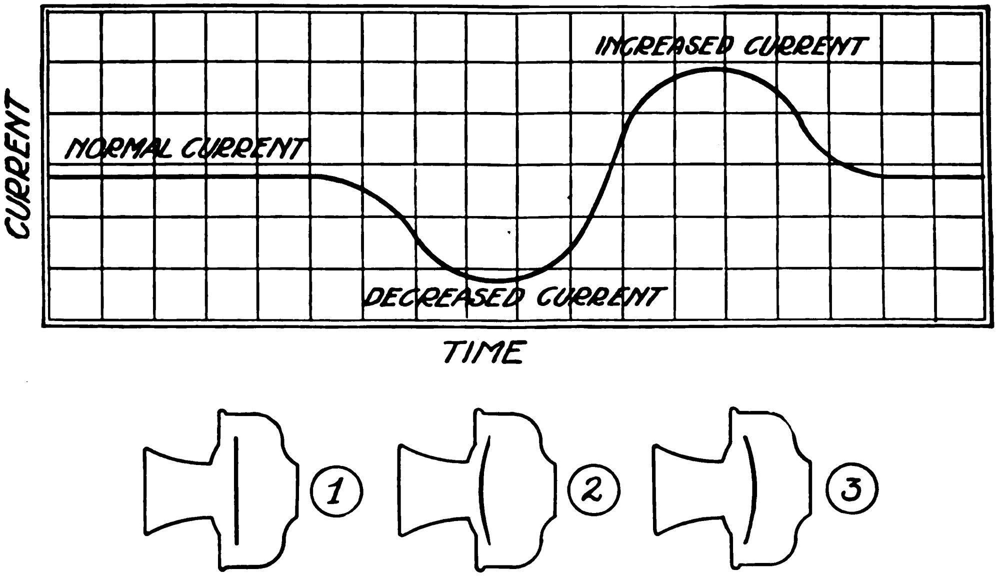


FIGURE 3: *This diagram shows how the electric current that flows through a microphone varies with the strength of the sound waves. The currents for the three positions of the diaphragm shown in Figures 1 and 3 are indicated.*

Someone may say: "If science understands what the ear is, and how it works, why is it that it cannot devise an artificial ear that can record sound waves?"

That is just what science has done. It has developed a device that changes sound waves into impulses in exactly the same general way as the ear does, except that the impulses are of an electrical quality and travel over wires instead of being nerve impulses which travel over organic wires called "nerves."

This brings us to our last question: How does this instrument, the microphone, change sound waves into electric currents?

This is really very simple, as we shall see. First of all, this artificial ear (the microphone) consists of an outer sounding board C (shown at 1, Figure 2), which gathers up the sound waves and impresses them on the diaphragm B. On the back of this diaphragm, fastened to it and free to move with it, is a sort of plunger contact D. This plunger contact passes through a flexible insulator disc A, which forms one wall of a cylindrical box E, which is filled with carbon grains. The cylinder is connected in an electrical circuit in such a way that the electric current from a battery G has to pass through the carbon grains in its path around the circuit. The only way it can pass through the carbon grains is to pass from one grain to another as they make contact with one another. If they are pressed tightly together a large current will flow through them, and if they touch each other only lightly, a small current will flow through them. If, for experimental purposes, we connect a measuring meter F in series with the circuit, we will be able to read the value of current flowing. If no current flows through the meter, the pointer will be at zero at the left of the scale, and as the current increases the pointer will travel over the scale to the right, recording an increase of current in accordance with its deflection.

Now if we place a microphone in position 1 (in Figure 1), in place of the human ear, the diaphragm will be in a normal position and the pressure exerted on the carbon grains contained by the cylinder E will be normal, and therefore a normal current will be measured by the meter F, flowing through the electrical circuit.

The diagram in Figure 3 further illustrates the normal value of the current that flows through the microphone, by the straight line just above the outline of the microphone with the diaphragm in position 1.

Now imagine the wave (Figure 1) to be passing by the microphone until the microphone is in position 2. The diaphragm will now be curved outward. Referring again to Figure 2, at 2, we see that when the diaphragm is curved outward it draws the plunger contact with it, and this lessens the pressure on the carbon grains. They are released and touch each other lightly and the current flowing through them is decreased. See how the current value falls off, for this condition, during the time when the diaphragm is in this position (2), Figure 3.

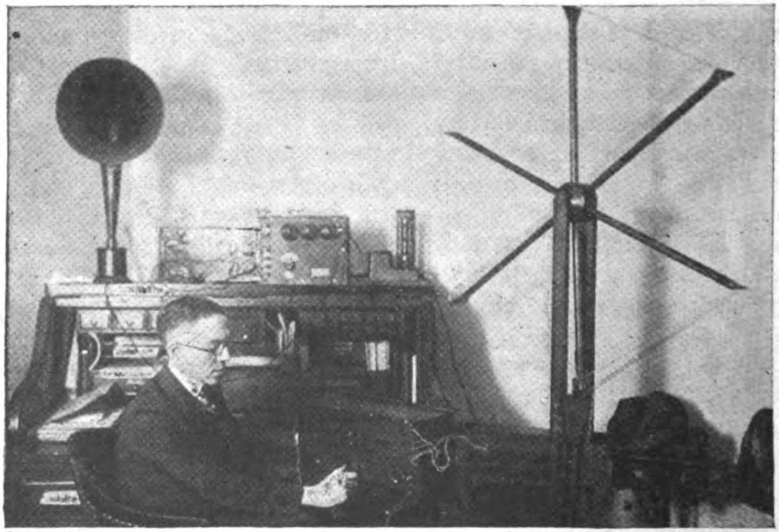
When the wave has advanced so that the microphone finds itself in the position 3 in Figure 1, the surface of the diaphragm will be curved inward.

Referring, once more, to the diagram (at 3) Figure 2, we see that the diaphragm pushes the plunger contact into the cylinder, compressing the carbon grains tightly together so that the resistance is decreased and a large current flows through them, as indicated by the meter F. Now see how the current gains in strength during the time when the diaphragm is in this position (3) in Figure 3.

If you compare the shape of the curve of the sound wave, in Figure 1, which is a measure of the air density, you will see that it corresponds exactly with the shape of the electric current wave in Figure 3, which is a measure of the current density.

Now ask yourself the three questions at the beginning of this article, and see if you can answer them in the affirmative!

In the next article we will consider how the telephone "receiver" converts electrical currents back into sound waves.



International

EXTENDING CONGRESS'S "GALLERIES" TO INCLUDE THE WHOLE NATION

Representative Vincent M. Brennan of Michigan recently introduced a resolution which provides that all the proceedings and debates of Congress be broadcast by the Navy's radio station at Arlington, Virginia. Representative Brennan is here shown at his own receiving set which he has installed in his office in the House Building in Washington.

From a photograph made for POPULAR RADIO

THE INVENTOR GIVES A DEMONSTRATION

Here is the "Greene receiver" in operation. It gets its name from Lloyd C. Greene who is not only a successful experimenter but also the radio editor of the Boston "Globe."

HOW TO BUILD A GOOD

Single-Tube Receiver

Radio fans in New England have met with such success in building and operating this simple but remarkably efficient set that a detailed description of it is here published for the benefit of readers everywhere. The tuning is simple, the range is exceptionally wide—and the parts can be bought for less than $33.00.

By A. H. RICE, JR.

TO meet with favor among the vast majority of radio fans to-day, a receiver should be simple to construct, efficient, inexpensive and, what is perhaps of even greater importance, easy to operate.

The receiver described has a wavelength range of 175 to 600 meters, and is provided with vernier controls on the filament rheostat and antenna tuning condenser—the advantages of which are immediately appreciated when tuning in long-distance stations.

A potentiometer is employed across the "A" battery, thus providing a vernier adjustment of the potential impressed across the plate and filament.

Regeneration is obtained by means of a variometer in the plate circuit, for it has been found that the tuned plate method of securing regeneration in the circuits is superior to either external capacity coupling between the plate and grid circuits or the present popular method of electromagnetic coupling between these circuits.

With the controls above noted, the circuits may be brought very close to the point of oscillation, which is a desirable feature, as it is possible to approach gradually a peak value of regeneration on a given wavelength without forcing the circuits into oscillation, as is the case with other types of regenerative receivers. By this means of control the novice is better equipped to pick up distant stations, because of the amplification obtained as this peak value of regeneration is approached.

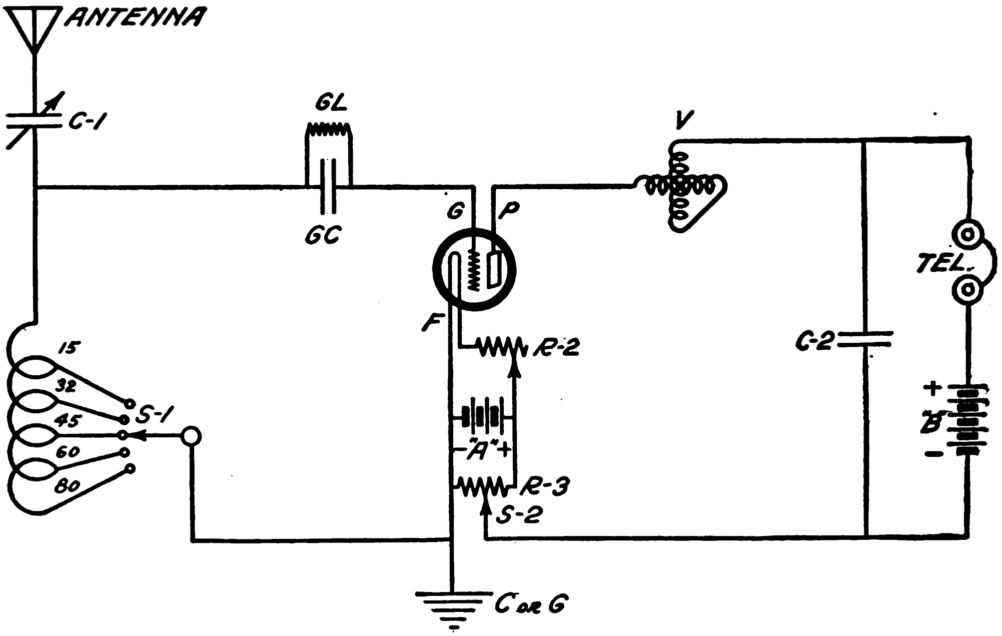
In addition the receiver is more selective in tuning than those of similar design because of the fact that it is possible to approach a higher peak value of regeneration without causing the circuits to oscillate; as it is a generally accepted fact that tuning becomes sharper as regeneration is increased, it will be readily understood why this feature is so desirable.

It is not essential that the constructor and operator of this set have an expert knowledge to operate it with a reasonable amount of success on phone reception. Nor does its construction require tools other than those usually available in the average household. A pair of pliers, a screw-driver and a soldering kit are the most useful tools to have at hand. However, if the panel work is to be done by the experimenter, additional tools will be needed. This work, however, can be done at any small shop at slight cost and those who are not equipped to do it themselves need not feel that the construction of a neat set is beyond them.

It should be borne in mind that the receiver contains no parts unnecessary to its successful operation; therefore it is necessary to follow instructions carefully and to subject the instrument to a thorough test before attempting to modify or improve upon it.

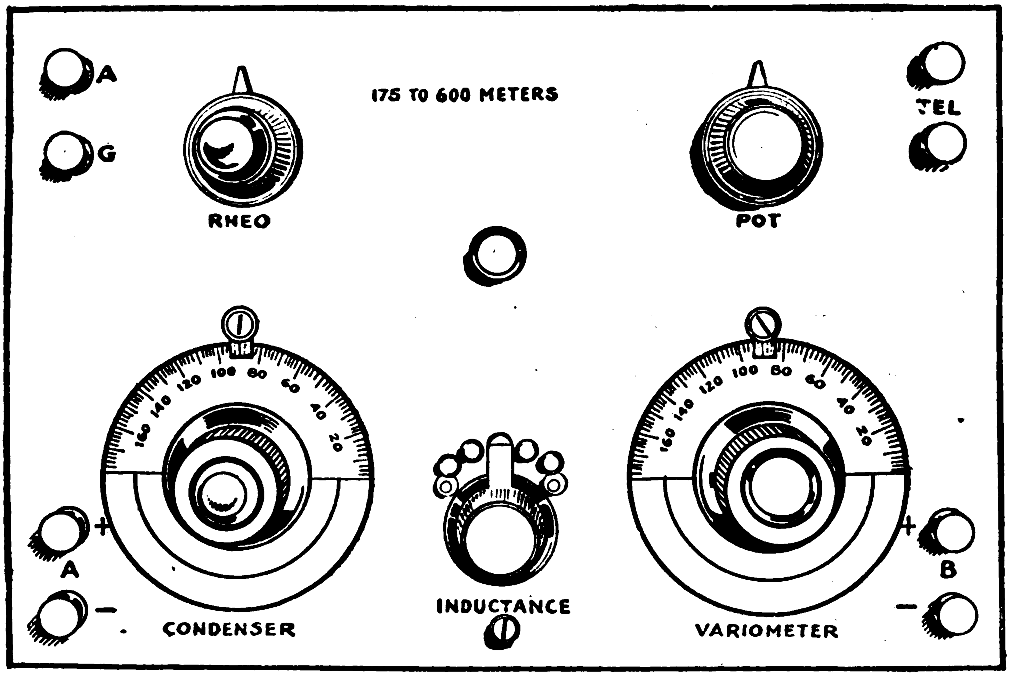
How to Build the Set

The standard size of panel used (8 inches by 12 inches by 3/16 inch) was chosen because



THE WIRING PLAN FOR THE RECEIVER

FIGURE 1: *The instruments should be connected exactly as shown in the diagram in order to get best results. The designations are the same as used in the text and the builder should, therefore, have no difficulty in putting the set together and operating it.*



THE FRONT OF THE SET

How the front of the panel appears after the dials and binding posts are attached. The terminals are plainly marked for the batteries and the telephones, and for the antenna and the ground.

it accommodated the various parts and accessories without undue crowding.

A suggestion is offered here to those who may desire to follow the panel layout of the model shown in the drawings: A pencil line is drawn lengthwise along the panel 2 1/16 inches from the bottom; a pencil line is next drawn from the top of the panel to the bottom 2⅞ inches from the left side or edge, and another an equal distance from the right-hand edge. The intersections of the horizontal line and the two vertical lines comprise the centers of the two 3¼-inch dials shown in the model. By using these dimensions it was found that the variometer could be utilized to support the panel upon which the other apparatus is mounted.

It will be noted here that a Remler variometer is used, although variometers of other reliable makes may be used.

Now draw a line lengthwise along the panel and parallel to the base, 1¾ inches from the top edge. The intersections of the two vertical lines and this horizontal line at the top of the panel indicate the positions of the potentiometer and rheostat knobs.

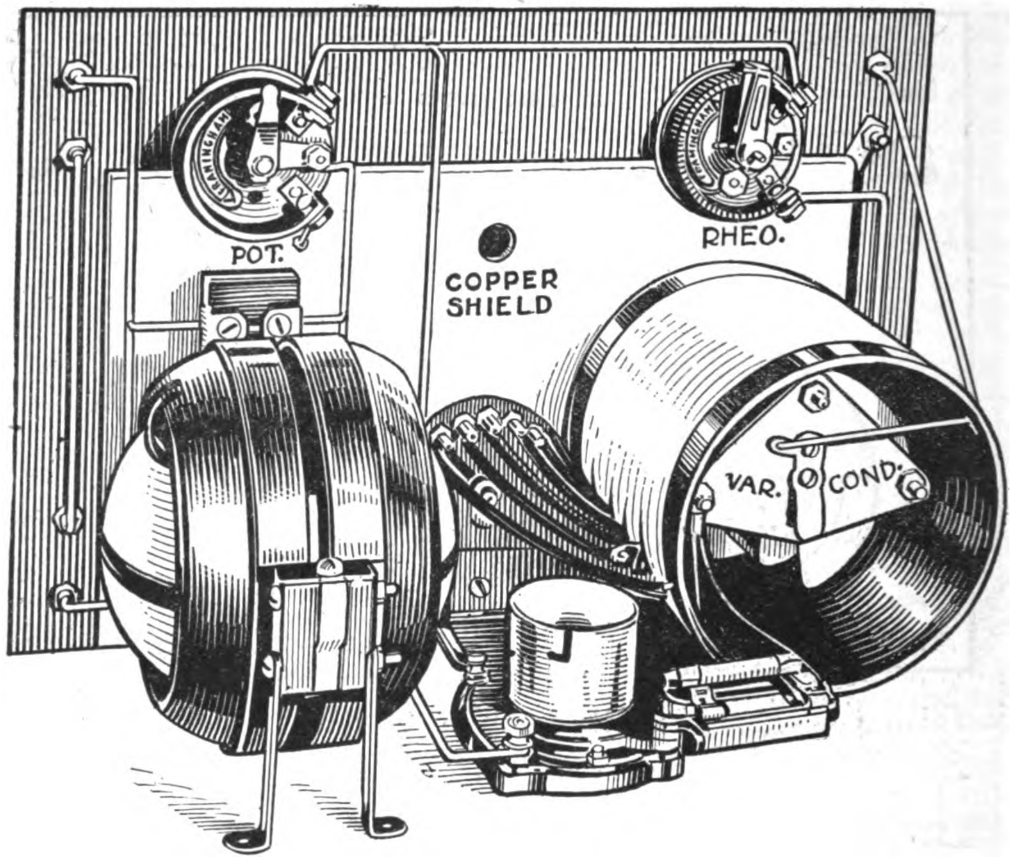
The location of the switch, binding posts and circular window for viewing the vacuum tube may be made according to the taste of the individual in balancing up the panel design. If it is desired to have the panel engraved, indicating the various controls, information may be obtained at any radio supply house regarding concerns equipped to do this work.

A copper shield should be used on the back of the panel as shown in the diagram. By its use body capacity effects are reduced when tuning and the wiring of the receiver may be greatly simplified by utilizing the shield as a return from different parts of the circuit which need to be connected to the "A" battery and ground.

When the set is properly wired, the inductance switch arm, negative side of the potentiometer, negative "A" battery terminal, negative filament lead from the vacuum tube, and the ground binding posts are all connected to the copper shield.

To apply the copper shield to the back of the panel proceed as follows:

Procure a piece of copper foil .001 inch thick. Cut this to a 6-inch by 9-inch sheet; apply a thin coat of shellac to that part of the back of the panel upon which the copper foil is to be fastened. Before placing the foil upon the panel, touch a lighted match to the back of the panel and allow the alcohol to burn off. The surface will then become sticky and when the copper foil is applied the shellac will dry quickly, making a smooth and neat job. When this is dry (which should not require more than five minutes), with a sharp pointed knife cut away the copper foil in all places where parts of the apparatus or wires, which should not be connected to the shield, might touch.



A REAR VIEW OF THE SET

Showing in detail the arrangement of the parts and the method of applying the copper shield.

Connect to the shield only those parts that are specified.

If the potentiometer is wired to the rheostat as shown in the rear view of the set, it will be in circuit only when the vacuum tube is lighted. This method of wiring eliminates the use of a separate "A" battery switch to open this circuit through the potentiometer when the receiver is not in use.

Now refer to the circuit diagram (Figure 1).

The symbols shown represent the following: The triangle in the upper left hand corner indicates the antenna, which may consist of one or two wires 100 to 120 feet long, supported at an average height of 30 feet; C-1 is a vernier variable tuning condenser with a capacity of .0005 mfds.; GL is a grid leak of ½ megohm resistance; GC is a grid condenser having a capacity of .00025 mfd.; (if a WD-11 tube, operating on one dry cell, is used, a 1-megohm grid leak and .00015 mfd. grid condenser should be employed).

G is the grid, F the filament, and P the plate of the vacuum tube; V the variometer; "TEL" the head telephones.

C-2 is a by-pass condenser with a capacity of .0005 mfd.

"B" is a 22½-volt "B" battery (note how the *plus* terminal of this battery is connected to the telephones).

L is a coil wound with No. 22 wire, either single or double cotton covered, on a bakelite tube 4 inches in diameter and 3½ inches long with taps taken off at the 15th, 32nd, 45th, 60th and 80th turns and brought to switch points, represented by the small circles in the diagram. S-1 is a switch lever for varying the wavelength.

"A" is a 6-volt storage battery, preferably of 80 ampere-hour capacity, (if a WD-11 tube is used, a 1½-volt dry battery is all that is required to light the filament).

Note that the *plus* terminal is connected to the rheostat which controls the current flowing through the filament by regulating the amount of resistance of R-2 in the filament circuit.

S-2 and R-3, "A" battery potentiometer, are connected as shown; C, at the bottom of the drawing represents the ground connection, or

WHAT THE PARTS COST

C-1—U. S. Tool variable condenser, .0005 mfd	$5.00
L—Tapped coil, wound with No. 22 S. C. C. copper wire	2.00
GL and GC—Dubilier combination grid leak, ½ megohm and grid condenser, .00025 mfd	1.50
C-2—Micadon fixed condenser, .0005 mfd	.35
R-2—Framingham rheostat	1.25
R-3—Framingham potentiometer	2.00
V—Remler or Atwater-Kent variometer	$9.00
Vacuum tube socket	.75
Vacuum tube	6.50
8 binding posts	.40
Copper sheet	.30
Panel	1.00
S-1—Switch and taps	.50
Connecting wire	.20
Total cost (approximately)	$31.75

better, the connection for the counterpoise.

If a counterpoise is used, the same precautions should be taken with it regarding lightning hazard, as are observed in the antenna installation. It should be equipped with an approved type of arrester, and to make doubly sure it should be grounded, when not in use, with a standard lightning switch. No one should entertain any misgiving regarding lightning, as it is a well established fact that a properly installed antenna system is the best kind of protection.

The receiver, when properly constructed, and connected to a single wire antenna 120 feet long, will enable one to hear amateur stations on 200 meters, radiophone broadcasting stations on 360 and 400 meters, and also commercial stations on 600 meters.

How to Operate the Set

To operate the receiver, connect antenna, ground (or counterpoise), "A" and "B" batteries, and telephones to the proper binding posts. Before inserting the vacuum tube in its socket make sure that all connections are correct and that the filament rheostat is in the "off" position. The rheostat is "off" when turned in an anti-clockwise direction as far as it will go.

When the vacuum tube is lighted by turning the rheostat knob in a clockwise direction, care should be taken not to burn the filament any brighter than is necessary to hear signals. When the WD-11 tube is used it burns so dimly at normal filament temperature that it is difficult to observe any glow at all.

Now let us suppose that the rheostat is turned half way on.

Set the inductance switch on the fourth switch point counting from the left. If no broadcasting is heard, turn the variable condenser, first in one direction and then in the reverse. Turn it *carefully*—do not spin it. If nothing is heard, try the third tap on the switch, varying the condenser as before.

When a signal is picked up, try increasing the inductance and at the same time decreasing the antenna tuning condenser. If the station can be picked up by using more turns on the coil and less capacity the sharpness of tuning at that particular wavelength setting will be increased.

When the signal has been tuned to give the loudest response in the telephone receivers, try rotating the variometer rotor in a clockwise direction and then in the reverse. If the filament temperature of the tube is too low, no increase in signal strength will result. Slowly increase the filament temperature of the vacuum tube until the desired effect is obtained when the variometer is rotated.

If a squeal is heard in the telephones as the point of loudest signal is approached in the variometer adjustment, turn it in the reverse direction slightly and resort to the potentiometer adjustment as a final means of obtaining the loudest signal without squealing being produced.

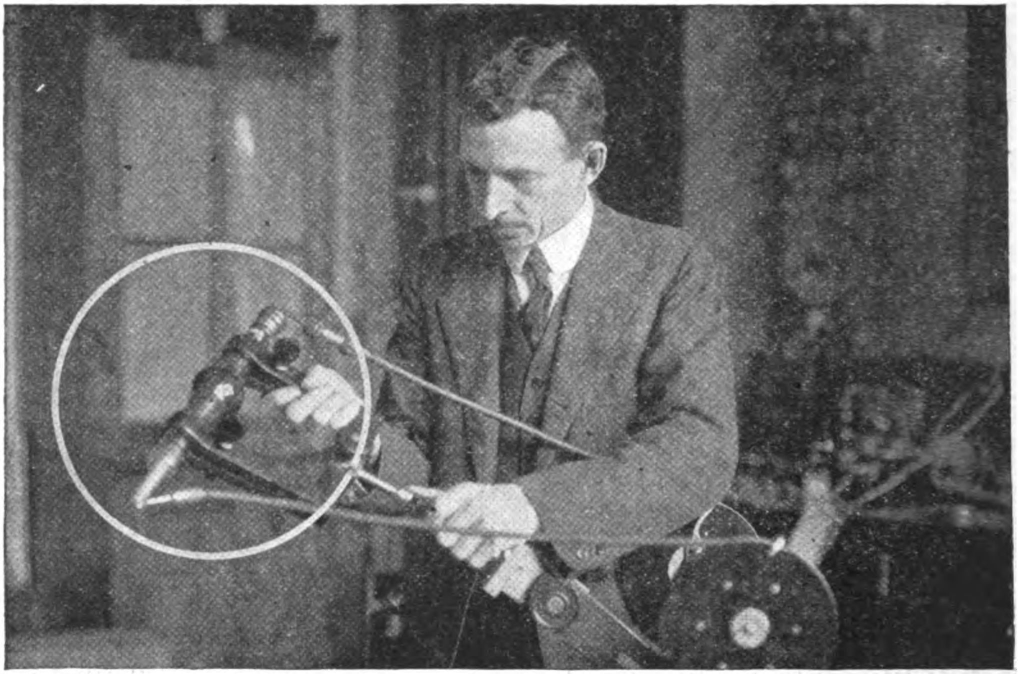
When properly operated the receiver is never allowed to go into oscillation—it is not necessary. If any squeals are heard when the set is not oscillating the causes are: either two broadcasting stations are heterodyning, or an oscillating receiver and a broadcasting station are heterodyning or two oscillating receivers in the immediate vicinity are heterodyning.

The circuit is equally efficient when a WD-11 vacuum tube is used, the only changes required being in the value of the grid leak and grid condenser and the addition of an "adaptor" which fits into the standard tube socket. This results in a considerable saving, as a 1½-volt dry cell may be used in place of the conventional storage battery. It then becomes an ideal set for portable work.

Numerous letters have been received from amateurs who have built the set, who have reported hearing stations between 1,000 and 2,000 miles distant more consistently and with much better audibility than they had been able to obtain before with a single tube.

A Combination Long and Short Wave Receiver

In a near issue of POPULAR RADIO *Lester A. Twigg will tell how to make a set for receiving long waves and short waves, that will enable you to pick up either the code or the broadcasting.*



General Electric

DR. COOLIDGE DEMONSTRATES HIS INVENTION, THE "COOLIDGE TUBE"

This is generally known as the hard X-ray tube—an electron discharge device that constitutes one of the most important of the applications of this phenomena to every-day uses.

THE NEWEST METHOD FOR EXTRACTING ELECTRONS

How the use of thorium is getting higher filament emission at a low temperature in the new vacuum tubes

So important to the radio amateur does POPULAR RADIO consider the work on electron emission, conducted by the assistant head of the great electrical research laboratories in Schenectady, that the following summary has been prepared of the various reports on the subject as given by him at the Carnegie Institute of Technology in Pittsburgh and before the members of the American Physical Society at Boston and representatives of the American Institute of **Electrical Engineers.**

By IRVING LANGMUIR, PH.D., D.SC.

WHEN metals are heated in high vacuum, electrons, or minute particles of negative electricity, evaporate from their surface. If there is another electrode in the evacuated space which is given a positive charge the electrons drift over to this electrode plate or anode so that a current flows between the two electrodes. Dushman has recently derived an equation which should supersede the well-known Richardson equation, giving the relation between the electron current and the temperature of the filament (cathode). The advantage of this new equation is that there is only one constant which we need to know for each different filament material, instead of two constants which were necessary for the Richardson equation.

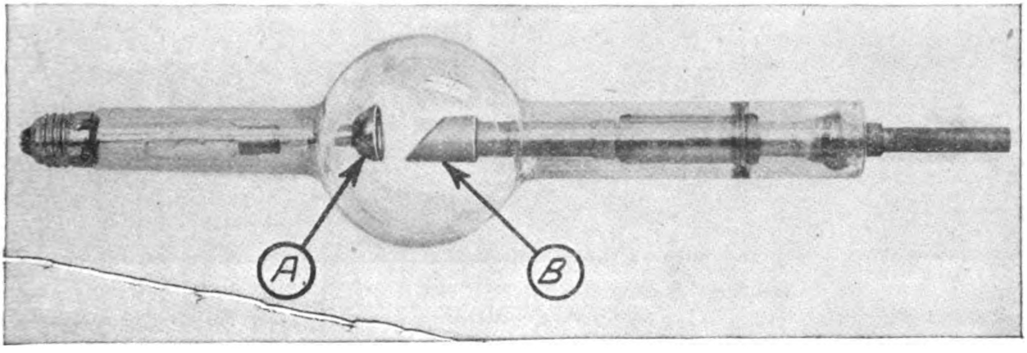
The electron emission from a large number of different materials has recently been measured. The thoriated tungsten filament gives a current at a temperature of 1,500° Centigrade absolute, which is about 130,000 times greater than that from ordinary tungsten. Measurements have also been made of filament materials that have even greater emissions.

In order to make use of the total electron emission that a filament is capable of giving, it is necessary to apply to the plate of the tube a high enough voltage to overcome what is known as the "space charge" effect. When small amounts of gases are present in the partial vacuum, positive ions are formed in the space between the filament and plate, and these tend to neutralize the negative space charge and allow the current from the filament to pass across the space at much lower plate voltages. In other words, the effect of gases is to increase the current-carrying capacity of the tube.

Such an effect is used in the tungar rectifier. Care must be taken as to just what gas is used for the purpose, for many gases have the effect of poisoning the filament, and cutting down its emission of electrons to a small value.

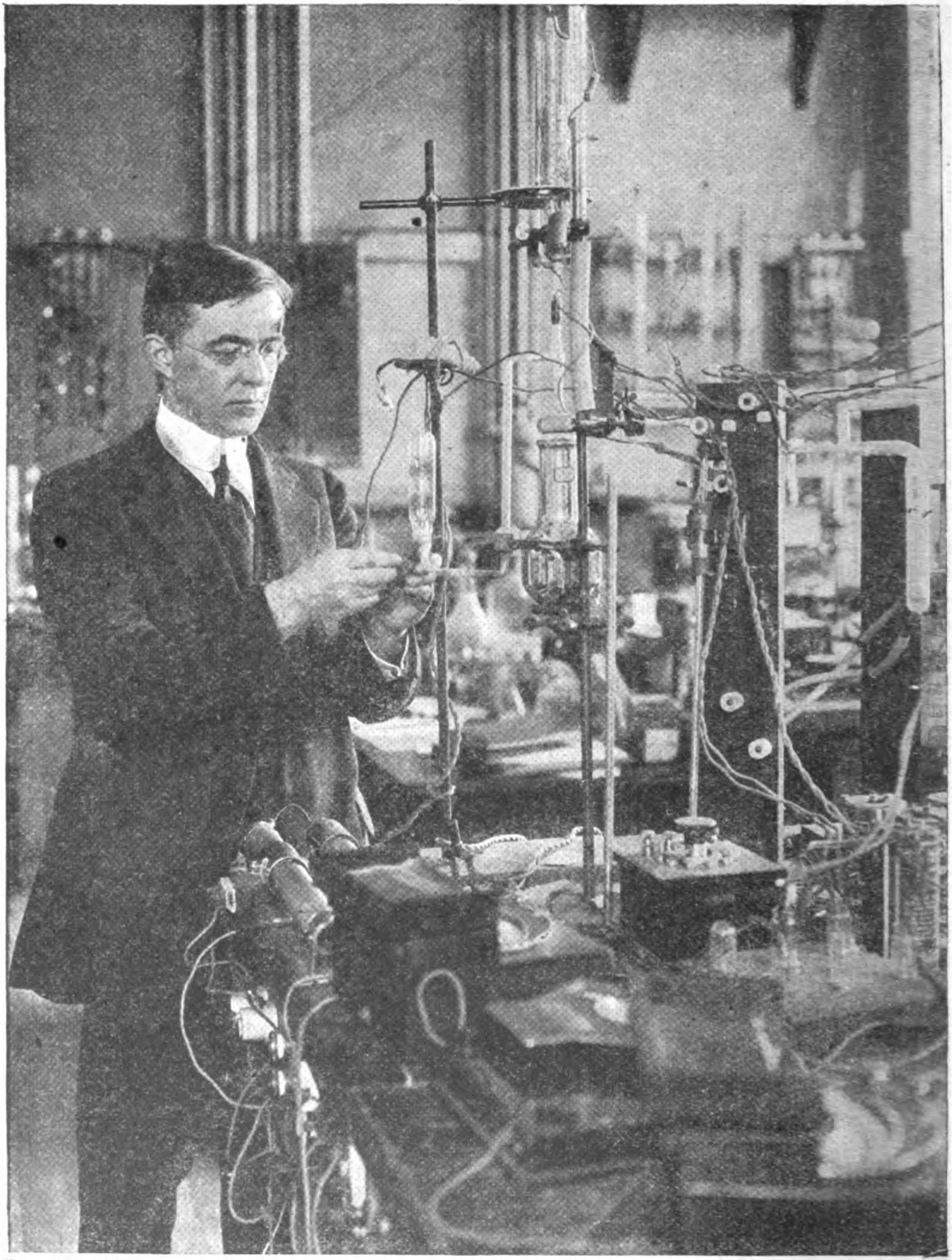
If very high voltages are used on the plate, so as to produce intense electric fields, it is possible to *pull* electrons out of the filament. In fact, it is possible to pull electrons even out of cold filaments, that is, filaments at ordinary temperatures. The currents obtained this way from the filament come from very minute areas, but in these areas the current density amounts to more than one hundred million amperes to the square inch.

The thoriated tungsten filament is a tungsten filament containing one or two percent of thorium, usually in the form of oxide. When such a filament is heated to about 2,500° Centigrade, a little of the thorium oxide is changed into metallic thorium. In the meantime, however, any thorium on the surface of the filament evaporates off, leaving only pure tungsten. If the filament temperature is then lowered to about 1,800° Centigrade, the thorium gradually wanders or diffuses through the filament, and when it reaches the surface (provided that the vacuum is almost perfect) remains there and gradually forms a layer of thorium atoms which never exceeds a single atom in thickness. The thickness of this film is therefore about .00000001 inch, yet this film increases the electron emission of the filament more than one hundred thousand fold.



THE FAMOUS X-RAY TUBE THAT ENABLES SCIENCE TO APPLY ELECTRONS TO RELIEVE HUMAN ILLS

It consists of two important elements; A is the cathode, from which the electron stream swarms across to the target B, around which the X-rays are propagated.



General Electric

ONE OF THE FOREMOST RESEARCH PHYSICISTS IN THE WORLD

Perhaps more than any scientist in the world, Dr. Irving Langmuir, of the General Electric Company laboratories, has contributed to the knowledge of electron-discharge apparatus—with which this article deals. Among his numerous honors in science are included such coveted awards as the Nichols, Rumford and Hughes medals.

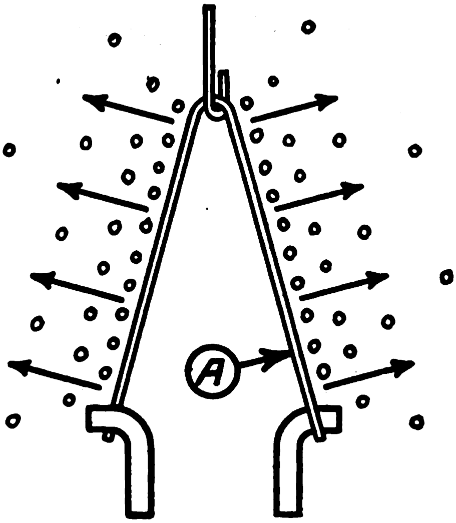
Two of the latest radio tubes which have recently made their appearance and are known as radiotrons UV-201A and UV-199 embody the new principle of the thoriated filament.

Of course this useful film is very sensitive and needs some protection to keep it in good condition. Very slight traces of water vapor or other gases would oxidize this film and destroy it.

This may be avoided by putting in the bulb some substance that combines with the water before it has a chance to attack the thorium film. One such a substance is metallic magnesium.

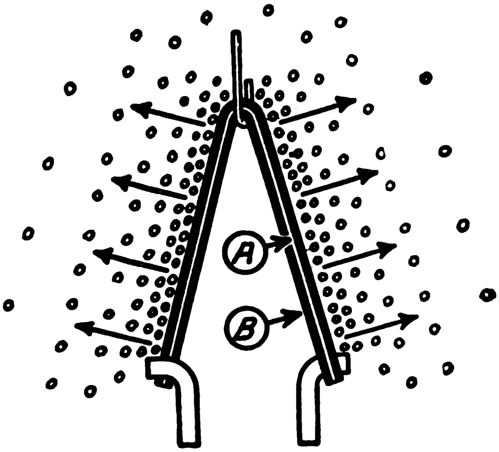
Furthermore, it is necessary to avoid heating the filament to too high a temperature, or the film might evaporate off. It is therefore best to operate such a filament within a rather narrow range of temperature close to 1,700° Centigrade, where the ratio of evaporation is small, and where the temperature is high enough for the thorium gradually to diffuse to the surface and continually repair any damage done by the effect of slight traces of residual gases.

The thoriated tungsten filament opens up many new fields of scientific investigation. By measuring the electron currents, it is possible to determine accurately exactly how much thorium is present on the surface. An amount of thorium corresponding to only one one-thousandth of the surface covered with a layer one atom deep is easily measurable in this way. It is possible to knock off a thorium film by bombarding it with positive ions, moving at high velocities, and in this way the true nature of the bombardment can also be determined.



THE ELECTRON DISCHARGE FROM THE ORDINARY FILAMENT

The arrows on this much-simplified drawing shows the direction taken by the electrons that are emitted from the heated tungsten filament, A.



THE ELECTRON DISCHARGE FROM THE THORIATED FILAMENT

Note the greatly increased emission of electrons from the tungsten filament, A, which has been coated with a minute layer of thorium, B.

Most of the applications of high vacuum tubes have depended upon the control of electron currents—as, for example, by the grid in the three electrode tube.

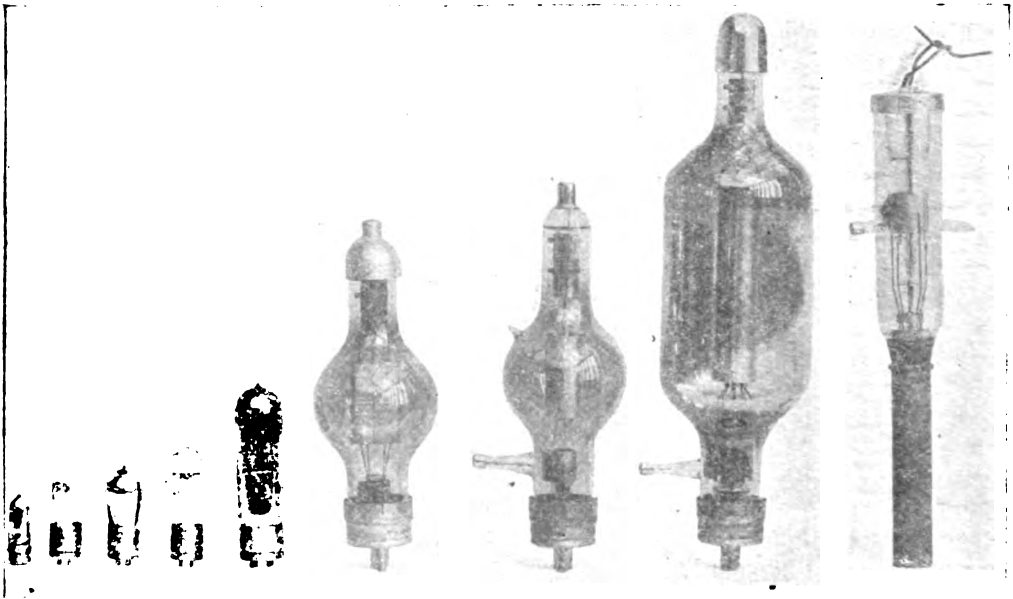
The action of the grid is due to the charge on the grid that modifies the space charge effect. This is the action that is employed in practically all tubes used to-day for radio transmission and receiving.

There are many other methods, however, of controlling electron currents. An important method is that used in the magnetron, where there are only two electrodes in the evacuated space and the control is obtained by means of a magnetic field generated by an external coil of wire. A still simpler form of magnetron suitable particularly to very large power tubes, consists of a very large straight filament in the axis of a cylindrical plate. The magnetic field produced by the current flowing through the filament is enough to prevent electrons flowing between cathode and anode. By heating the filament with alternating current which periodically falls to a low value, a large electron current can be made to flow from the filament to the plate also periodically. This gives a pulsating or oscillating current, which can be used for radio transmission. A 1,000-kilowatt tube of this kind is in process of development; preliminary tests have been in every way satisfactory.

Another form of tube by which electron currents can be controlled is the dynatron. This depends upon subjecting one of the three electrodes in the tube to electron bombardment in such a way as to cause electrons to be splashed out of it, just as water can be splashed out of a cup by attempting to fill it too rapidly from a faucet. A tube of this kind acts like a real negative resistance, and may be used for producing electrical oscillations with considerable efficiency.

One of the most important of every day applications of electron discharges from hot cathodes is in the Coolidge X-ray tube, which is now almost universally used as a source of X-rays. These tubes were first made about 1913 and are gradually being improved in many respects. The latest type of tube, suitable for use by dentists, is a small tube weighing only a few ounces, and only about three inches long. Because of the special features of this tube, the entire X-ray outfit, including the transformer, lead screen and regulating apparatus, weighs only a few pounds and takes up a space of only a small fraction of a cubic foot.

One great advantage of this new form of tube, besides its convenience, is its absolute safety, even in the hands of inexperienced operators, for there are no high voltages in any part of the apparatus which is accessible.

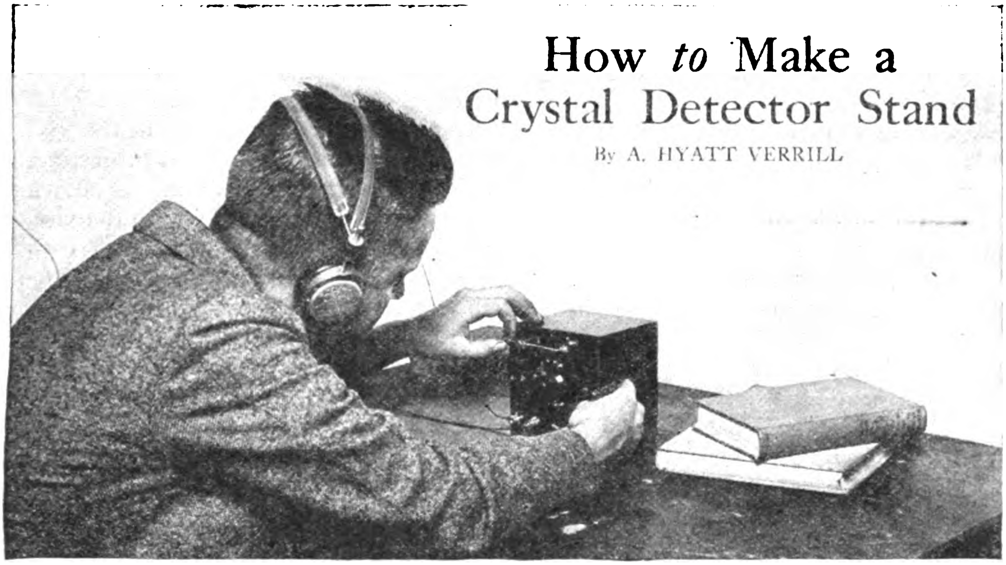


General Electric

The three tubes at the left are for receiving; two of them have the new thoriated filament. The other six are for transmitting; they range from 5 to 20,000 watts output.

How *to* Make a Crystal Detector Stand

By A. HYATT VERRILL



From a photograph made for POPULAR RADIO

FINDING THE SENSITIVE SPOT

The value of a crystal set depends upon the rectifying qualities of the crystals. It is important, therefore, that the stand which holds the crystals should facilitate the finding of the sensitive spot. This article tells how to build one for 75 cents.

ALTHOUGH a crystal detector is a simple instrument, and while almost any home-made set will work after a fashion, nevertheless a great deal of its success depends upon the efficiency of the apparatus itself. A really good detector must possess several important features which are often lacking in cheap, ready-made instruments and are always absent in roughly made "cat whisker" affairs such as the average novice devises.

Not only must a detector have perfect contacts and connections throughout but it must be capable of adjustment in various directions and must be rigid—for in order to obtain good results the most sensitive spot on the galena crystal must be found. This can only be done by "feeling" over the crystal with the fine wire or "cat whisker" contact. If the latter is fixed, or if it is merely provided with a coil or spring on itself, it is practically impossible to "feel" unless the crystal is moved about, which is a clumsy and unsatisfactory method. Furthermore, even when the most sensitive spot is found and the contact is established, a slight jar or vibration may throw it off again, and a new adjustment must be made. Of course anyone who is accustomed to the use of machine tools and who owns a set of screw-taps and dies can make a good detector, but those amateurs and beginners who are not familiar with metal working and who do not own taps and dies naturally do not care to purchase them merely for the purpose of making parts of their sets.

The detector shown in the accompanying diagrams has been designed especially for those who wish to construct their own instruments but who are not skilled in the use of metal-working tools or have none. If the detector is made neatly and according to the following directions it will be found fully equal to any of the ready-made instruments—indeed, better than the majority. Moreover, it may be made at a total cost of less than 75 cents.

The only tools needed are a small iron vise, a screwdriver, a pair of flat-nosed pliers, a soldering iron, a jackknife, a small hammer, a file, a hack-saw and a few drills. A breast drill or an ordinary bit-brace with some bit-shanked twist drills will answer all purposes. Even if you have to purchase the drills to fit your bit-brace the cost of the detector should not be over $1.25 or $1.50; such drills are almost a necessity if you intend to install or make a radio set.

The materials required are some sheet brass of about 1/32 inch and 1/8 inch thickness, a brass rod 5/16 inch or 3/8 inch in diameter, a short length of fine phosphor-bronze, brass or platinum wire, a few 5/32-inch or 1/4-inch brass screw-headed bolts with nuts, a few brass lock-washers or spring washers of the same size as the bolts, two binding-posts and some knurled thumb-nuts to fit the bolts or some binding screws and nuts from old dry batteries, a piece of wood or fiber about 1/2 to 3/4 inch thick and 4 inches square, and a piece of brass tubing with an inside diameter which will slip easily over the brass bolts.

This may appear to be a formidable list, but as the pieces are all small it really amounts to very little. If you have a pair of tinner's shears (which may be purchased for 50 cents) you can easily cut the thinner brass yourself; otherwise, you can get the nearest tinsmith to cut it for you, or can manage with a hack-saw and file.

The first thing to make is the rod that carries the contact wire or "cat whisker." This is a 5/16-inch or 3/8-inch brass rod 2 1/4 inches long as shown in Figure 1. In one end of this rod drill a small hole, and insert the fine wire, which should be bent as shown and should project from the rod about 1/2 inch. Solder this wire in position and turn to the next part. This is the holder for the rod and consists of a strip of brass about 5 inches long, 1/2 inch wide and from 1/32 inch to 3/64 inch thick. Bend this back upon itself at the center, as shown in Figure 2; this is best done by holding the strip in the vise and bending it sharply over (tapping with a hammer along the fold until a right angle is formed), and then bending the sides down close together by hammering along the bend.

Next, grip the folded strip in the vise with 1/2 inch of the folded end projecting, and bend it over at right angles, as shown in Figure 2A. Place the strip in the vise, with the free ends projecting, and with the top of the vise jaws 3/4 inch from the right angle bend. Spread the free ends apart and force a brass or iron rod or bolt 1/4 inch in diameter between them, as shown in Figure 2B. By gently tapping with the hammer and bending back the ends with pliers, form the two sides of the strip as in Figure 2C. The strip, when removed from the vise, should now appear as in Figure 2D.

Round and smooth off the sharp corners and edges, as shown, by means of a file. Bore holes the size of your brass screw-headed bolts (or of the terminal screws from the old dry battery) through both sides of the brass, as shown. When you bore the hole through the free ends, secure the ends in the vise or you will have trouble. Also, make this hole a trifle larger than the screw. Insert the brass screws or bolts through these holes and solder the heads firmly to the brass strip as indicated in Figure 2E.

Now take a strip of 1/8-inch brass, 3 inches long and about 3/4 inch wide and make a good sharp right angle at 3/4 inch from one end as shown in Figure 3. In this bore four holes the size of the brass screws or bolts—three holes in the short leg of the angle, as shown, and one near the upper end—about 3/8 inch from the end, as shown in Figure 3A. Round and smooth the sharp corners and edges and attach the strip to a neatly-made and finished panel or base of wood, fiber or Bakelite as indicated in Figure 4. Use two round-headed wood screws to secure the brass strip to the base and in the third hole on the short angle place a binding post or terminal screw, as illustrated in the diagram.

Assemble the contact rod and holder as shown in Figure 4 and 4A, attaching

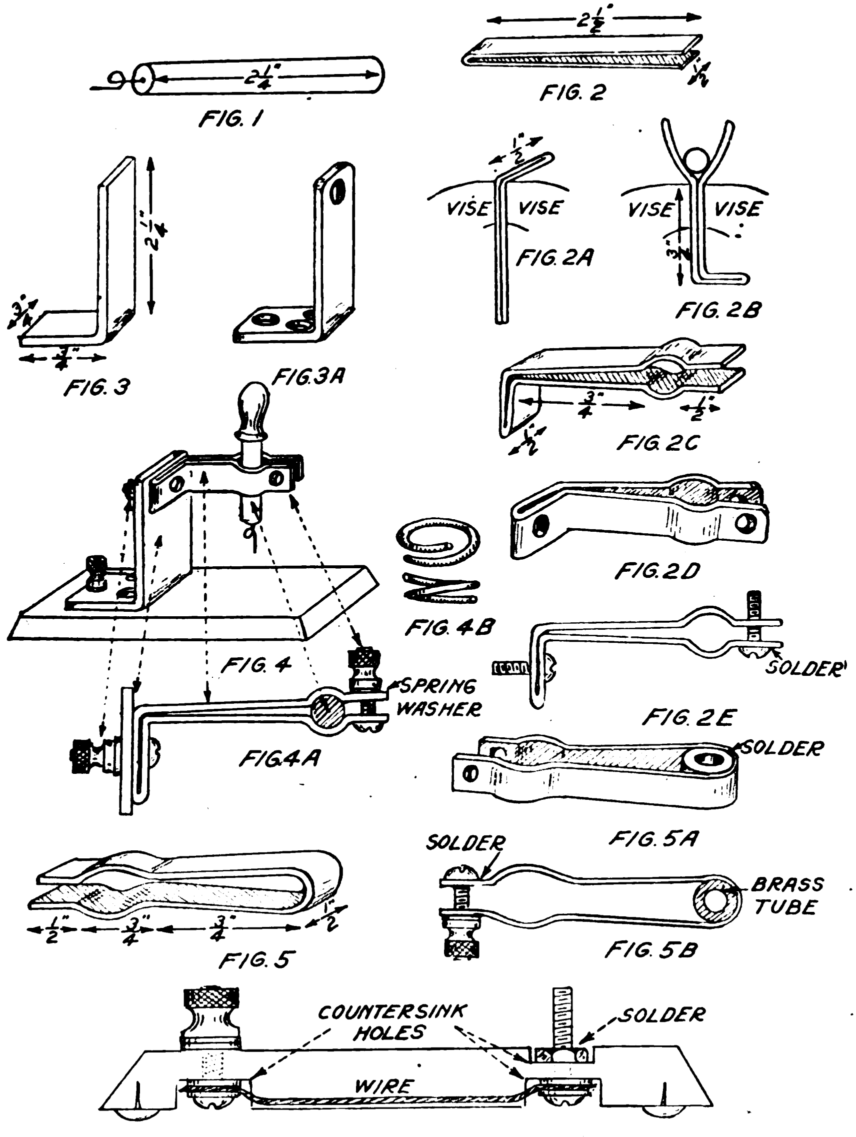


FIG. 6

THE PARTS FOR THE CRYSTAL STAND

This diagram gives the detail of the small metal parts which go to make up the stand, and indicates the proper methods for assembly. Figure 1 shows the detail of the rod and "cat whisker." Figures 2 to 3A show details of construction for the rod support. Figures 4 and 4A show how they are mounted on the base. Figures 5 to 5B show the details for the crystal holder. Figure 6 is a side view of the base, showing how the screw, which holds the binding post, is connected to the crystal holder by a wire run underneath the base.

the holder to the upright by the screw and using a spring washer and knurled thumb-nut, as illustrated in Figure 4A, and a similar nut and washer on the screw that holds the two free ends of the holder together. If you have no spring washers you can readily make excellent ones by cutting sections from a brass spiral spring, as shown at Figure 4B.

Now slip the rod, Figure 1, through the holder and slip the rubber bulb of an ordinary medicine dropper over the end,

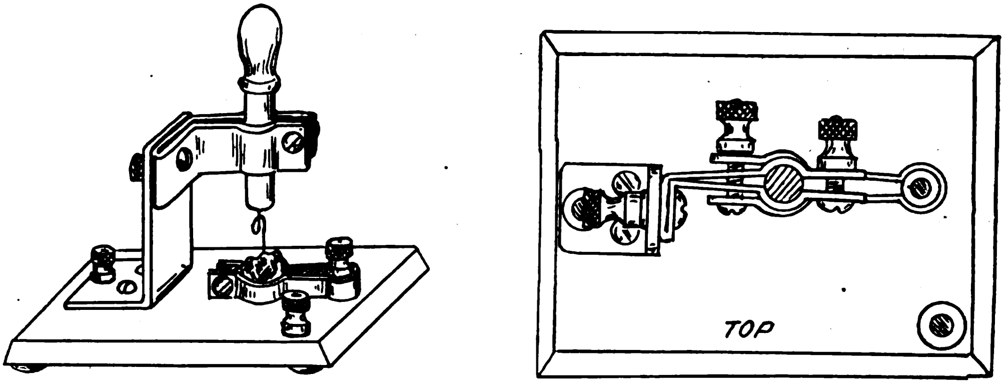


FIG. 7 FIG. 8

THE COMPLETE ASSEMBLY

Here are shown a side view (Figure 7) and a view from above (Figure 8) of the detector stand as it is finally put together for use.

as shown in Figure 4, 7 and 8, or fit a hard rubber knob to it. By tightening on the thumb nut at the free ends of the holder the rod will be held firmly, and by loosening it, it may be turned or moved up and down as desired. The spring washer and nut which secure the holder to the upright may be adjusted so that the holder is immovable, swings freely or binds at any intermediate point.

Next make the crystal holder by bending a strip of the 1/32-inch brass, ½ inch wide, in the form shown in Figure 5. Make the semicircular bend or fold at the center around a ¼-inch or ⅜-inch rod, and in the bend solder a short section of brass tubing with an inside diameter that fits snugly over one of your brass bolts, but that does not bind, as shown in Figure 5A. If the hole in the tube is too small it may easily be enlarged by running a drill through it; if it is too large it cannot be made smaller. Accordingly if you cannot secure just the right size get a tube a trifle too small and bore out the hole to suit. Bore a hole to take one of the screws through the free ends as shown, making the hole on one side slightly larger than the screw to allow some play, and solder the head to the other side as you did with the rod holder. Fit a washer and thumb-nut on the screw as in Figure 5B.

Now place the crystal holder upon the stand or panel, as shown in Figures 7 and 8, with the crystal grip under the end of the contact rod when the latter is in the position shown in the cut, Figure 7, and in line with the upright. When in the proper position, mark where the hole in the brass tube comes, and after removing the holder bore a hole through the base to take one of the brass bolts, countersinking a space to take the nut on the upper surface of the panel as in Figure 6. Bore a similar hole at the other side of the panel and countersink both holes on the under side to accommodate washers and screw-heads, shown in Figure 6. Insert a long screw in the hole to secure the crystal holder, placing two washers between the head and the lower surface of the panel, with a wire between them as illustrated. Screw the upper nut down tightly, by holding it with the pliers and turning the screw-headed bolt with a screwdriver, and solder the nut firmly to the bolt.

In the other hole, place a binding-screw as shown in Figure 6 and connect the wire as indicated, cutting a groove in the bottom of the panel for the wire so that all will be flush on the bottom. It is a good plan, however, to place a leather-headed upholsterer's tack at each corner, as this will give a firm bearing and will prevent the panel from slipping when in use. If you have any trouble in working at these things with the upright and contact-rod in place, you should remove them as soon as the position for the crystal holder is marked.

Finally, assemble the crystal-holder as shown in Figures 7 and 8, place the crystal in it and clamp it tightly; the detector is then ready to connect and use.

By keeping a slight tension on the spring washers under the thumb-nuts, the parts may be moved for "feeling" and yet will not be jarred out of position. By tightening the nuts the parts may be securely locked in any position desired. The whole affair is very compact, as the base is but four inches square.

What Radio Is Doing for the Farmer

¶ In none of the many fields into which radio has entered does it promise to render more essentially practical and valuable service to so many people as in the field of agriculture. How the government authorities are broadcasting specific information concerning the planting, raising, packing, shipping and marketing of farm products will be told in a near issue of POPULAR RADIO.

General Photographic Service

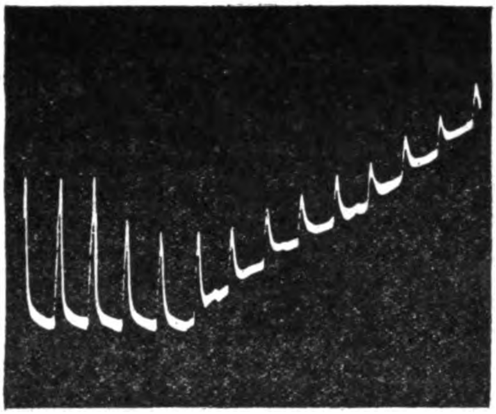
A RADIO STATION WITH SIX CYLINDERS

When Mr. and Mrs. J. C. Davenport of Indianapolis, Indiana, set out in their radio-equipped automobile on a 40,000-mile state to state pilgrimage, it was both to enjoy a vacation and to demonstrate the usefulness of radio on tour. How they succeeded may be judged from the crowds that gathered to hear the radio entertainment they furnished whenever they stopped.

Hollinger, N. Y.

The Man With a Radio Eye

Of all the experimental work done by the East Indian scientist, Sir Jagadis Chunder Bose, none has been more remarkable than his creation of what is, in effect, an artificial sense-organ that is infinitely more responsive to the certain rays with which we deal than is the ordinary photographic plate or the human eye.



THE DEATH-THROES OF A CARROT

This oscillogram shows the crescograph response of a carrot before and during a period that it is subjected to chloroform. At the left is shown the normal response and to the right is shown the response growing weaker and weaker as the plant expires.

MACHINES THAT RECORD

The Voltages of Peas

THE subject of the following article, Dr. J. C. Bose, has been all his life a storm center of scientific controversy. His revolutionary ideas of the nature of plant life and of the ways in which plants respond, by microscopic movements, to injuries and to disturbances of their surroundings; his almost mystical interpretation of some of his delicate physical experiments, have brought down upon him some criticism from many of the more material-minded students of plant physiology. But all of Dr. Bose's critics credit him with being an extraordinary successful designer and manipulator of physical instruments. His apparatus for detecting minute movements and electrical changes in plants is, admittedly, the most delicate that has ever been built. The radio world, which was, as Mr. Kaempffert points out, one of the first fields of Dr. Bose's work, suffered a serious loss when his inventive genius was turned away from it into the investigation of the properties of living matter.—EDITOR

By WALDEMAR-KAEMPFFERT

SIR JAGADIS CHUNDER BOSE (pronounced Bo-zay) is an extraordinary figure. He is the first oriental who has won for himself a commanding place in modern physics.

Here is a devout, intensely religious Bengalese of the purest blood who has perfected the most delicate instruments for accurately measuring the reaction of plants and so-called "dead" metals to alcohol, ether, heat, light, and forces of every imaginable kind, and who has laid bare the molecular mechanism of living and "dead" matter's reaction to a hundred different stimulants and thus upset our time-honored notion that orientals in general and East Indians in particular are much too metaphysically inclined to conduct research in the modern scientific spirit.

Not only has Bose opened up an entirely new realm in physics but he even regards his startling discoveries as a scientific confirmation of the traditional doctrines of his people. His work is of such importance that it has been at last adequately recognized by the leading scientific societies of Europe and America

—among them the famous Royal Institution of London.

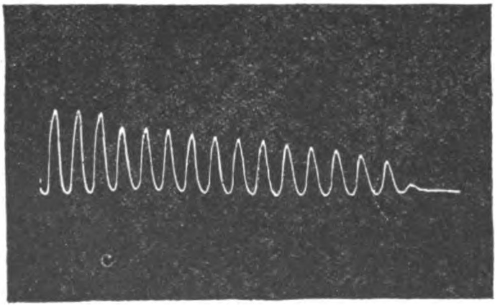
Bose's announcements that metals wince under blows, that they become torpid when frozen, that they can be narcotized like a living animal, and that they become weary from mechanical abuse were so astounding that they were long unappreciated at their true scientific value.

Similarly, his investigations of plants (conducted purely from a physicist's point of view) which revealed the whole mechanism of plant responses to heat, electric currents, ether, and mechanical shock were long incomprehensible to biologists familiar only with the microscopic method of studying living tissues. His instruments are of marvelous delicacy. With their aid he reveals the death-throes of a carrot, measures the voltage of a single pea, makes a cabbage leaf visibly shudder with pain and causes a geranium literally to start when a door is slammed.

Bose first drew attention to himself soon after Hertz had experimentally proved the existence of the waves which are now practically applied in radio communication. Those were the days when the coherer was the most efficient detector known.

THE EFFECT OF ETHER ON A GERANIUM

A graphic record, as made by the crescograph, of the reactions of a live plant which had been "put to sleep" by ether and then awakened.



HOW POISON AFFECTED A VEGETABLE

In this instance the vegetable was put to death. Note the effects of the drug, as shown by the gradually lessening response of the reactions.

Bose succeeded in producing waves of a length so short that he bridged the gap between the heat waves of the spectrum and Hertz radiations. He devised a detector far more sensitive than the familiar Branly coherer—a detector which depended not upon metal filings or powder but upon fine wire springs, adjusted with a thousand regular contacts and under the control of a screw. This detector proved to be far more sensitive than Branly's coherer.

He made one of the most exhaustive studies on record of the optical properties of the Hertzian waves—work which was commented upon with admiration in this country by Dr. Kunz of the University of Illinois.

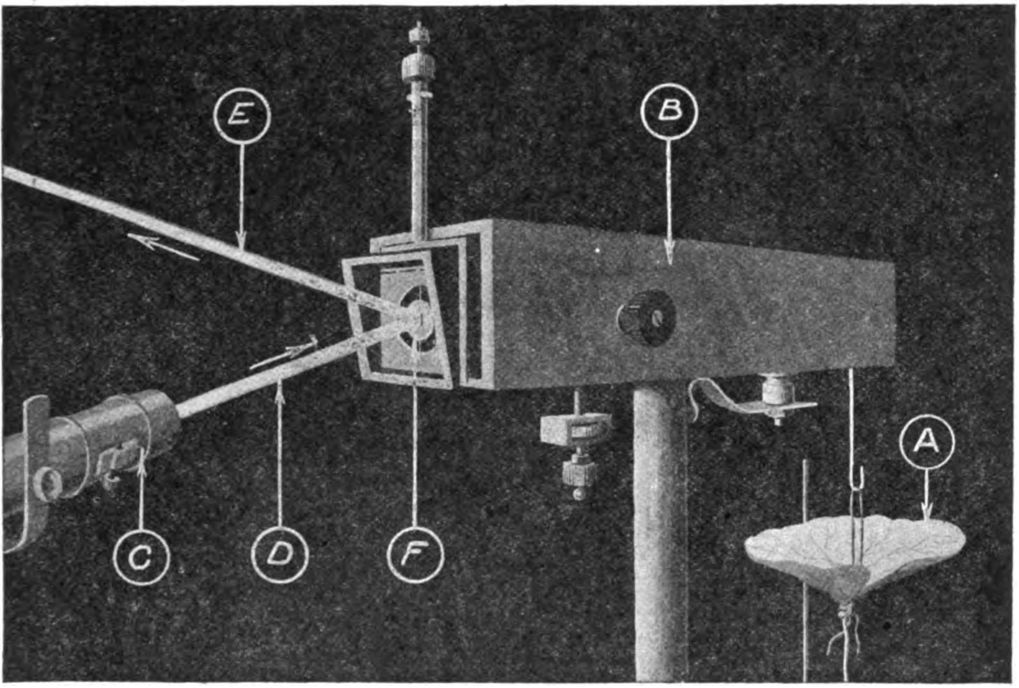
During the course of these experiments Bose conceived the idea of constructing an artificial sense-organ which would have a range of sensitivity far wider than that of any known eye, photographic plate or radio detector—something which not only would see visible rays but the invisible rays with which we deal in radio.

So he devised such an artificial sense-organ.

When he placed before it a glass of water—the equivalent of the eye's *aqueous humor*—all electric and heat rays and some ultra-violet rays were absorbed, as they are by the human eye.

The brain of this eye was a galvanometer. When he removed the glass of water the "eye" became exceedingly sensitive to radio and heat waves. Instead of marveling at his own ingenuity Bose simply remarked:

"Perhaps we do not sufficiently appreciate, especially in these days of space-signaling by Hertzian waves, the importance of that protective substance which veils our sense against insufferable radiance."



From a drawing by Henry M. Picken

HOW THE REACTIONS OF PLANTS ARE RECORDED

A is the plant under observation which is held taut by a thread and lever fastened to the recording apparatus. B is the crescograph proper which contains a sensitive balanced magnet, which tranfers the reactions of the plant to the small vibrating mirror F, so that a beam of light D projected from a lamp C is reflected along a path E to a sensitized screen which makes a permanent record like those shown on preceding pages of this article.

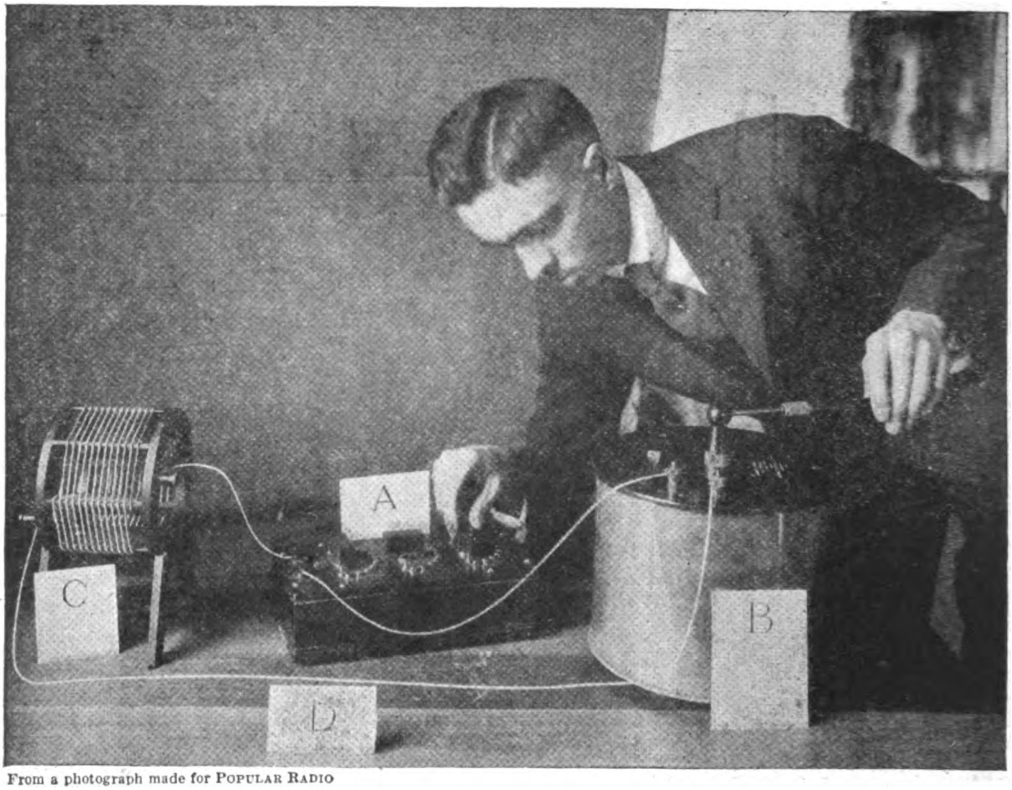
Dissect this artificial eye and what do we see?

Merely two tiny crystals of galena, adjusted to contact-sensitiveness. These experiments, made about 1900, probably revealed for the first time the possibilities of the crystal detector. Bose may, therefore, be regarded as the pioneer of crystal detection.

Most astonishing of all is Bose's discovery that plants respond to radio stimulation. He showed that very short electric waves retard growth. He proved with his magnetic crescograph, which magnifies plant reactions ten million times, that the perceptive range of a plant is inconceivably greater than ours. It may be that all the waves sent out by ships, great transatlantic stations, and by hundreds of broadcasting stations have an effect on vegetation which we may some day be able to understand.

How to Make a Good Tube Receiving Set for Less Than $16.00

IN *the next issue of* POPULAR RADIO*—July—will appear a complete and detailed description of a remarkably simple but efficient long-distance receiver that any amateur of ordinary proficiency with tools may build at home. Ask your newsdealer* TODAY *to reserve a July copy for you!*



From a photograph made for POPULAR RADIO

THE "PHANTOM ANTENNA" USED FOR LABORATORY TESTS

The author demonstrates the resistance box, A, which can be set at any value of resistance to be substituted for the resistance of the antenna; B, the variable condenser, which substitutes the capacity; D, the wire substituted for the ground, and C, the coil which furnishes the inductance which would be found in the real antenna. Mr. Strock is connected with the Bureau of Standards, and the following article was prepared by permission of the Director.

HOW TO DETERMINE THE Constants of Your Antenna

Do you know the capacity of your aerial? Do you know its resistance? Do you know its inductance? If not, you do not know whether or not you are getting maximum results from it. This article tells you how to find out.

By MORRIS S. STROCK

WHETHER an antenna is a poor or a good receiver of radio waves depends to a great extent upon its constants (electrical properties which can be determined by measurements or sometimes estimated or computed) and by another property of the antenna, "effective height."

The term "constant" is somewhat misleading because some of these electrical properties of an antenna vary greatly with the length of radio waves to which the antenna is tuned. But *at a particular wavelength* the constants of an antenna when used with a ground do remain much the same for a considerable period.

What are the constants of an antenna?

(1) Resistance;
(2) Capacity;
(3) Fundamental wavelength, and,
(4) Inductance.

The resistance of an antenna is the opposition which it offers to the flow of the high-frequency (rapidly reversing) currents induced in it by the radio wave. High-frequency or radio frequency currents flow only on the surface of a conductor. Therefore if the surface area is increased the resistance will be reduced. Antenna resistance is a complex quantity, but it may easily be expressed in ohms.

The capacity of an antenna is a property which enables it to hold a certain electrical charge, and then to discharge this in the form of electrical energy through the receiving set to earth. Capacity is expressed in microfarads.

The fundamental wavelength of an antenna is the length of the wave to which it will respond when it is connected directly to earth. Thus if an antenna has a fundamental wavelength of 290 meters, electrical vibrations or oscillations will be set up in the receiving antenna by a transmitting station that is sending out signals of this wavelength.

The inductance of an antenna is a sort of electrical inertia which retards the changes in the rapidly reversing current induced in the antenna by the incoming radio wave.

On page 448 is shown an artificial antenna in which the required value of resistance is obtained by adjusting the box A and the required value of capacity by adjusting the condenser B; while a fixed value of inductance is obtained in the coil C. The wire D represents the conducting earth under the antenna. The condenser B consists of two sets of overlapping plates which are at all times insulated from each other.

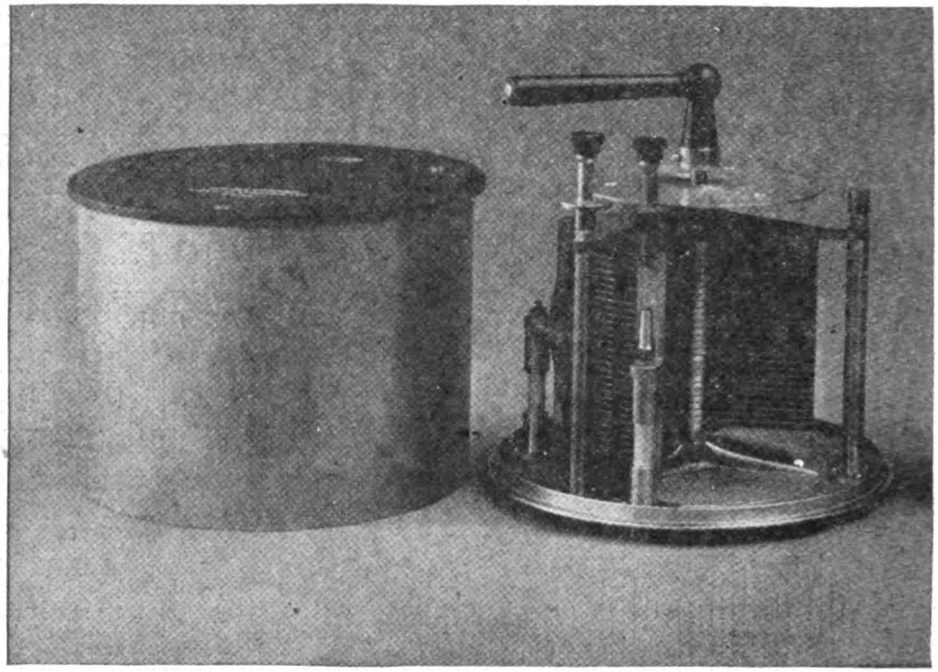
The interior of the condenser is shown in Figure 1. An antenna is a condenser in which the wires and the earth take the place of the two sets of overlapping plates. The coil C has about the same inductance as the average simple receiving antenna. If the wire in the coil is unwound and pulled out straight, its inductance is much less. This explains why the long wire in an antenna has so small an inductance value. In practice no attempt is made to secure a certain value of antenna inductance. The constants in the artificial antenna are "lumped"; in a real antenna they are "distributed."

If the inductance and capacity of an antenna (artificial or real) are increased, its fundamental wavelength is increased. (The capacity is more easily changed than the inductance.) The resistance has no effect on the fundamental wavelength, but if the resistance is increased the current induced by the radio wave is decreased.

Imagine that the inductance of the artificial antenna is "distributed," and that the coil C is the tuning coil of the receiving set. Then we may connect a variable condenser across the terminals of the coil, and thereby increase the wavelength to which the complete antenna system will respond. To decrease the wavelength of the system, we may insert the condenser in the wire leading from the right-hand terminal of the coil to the box A.

The artificial antenna on page 448 is a poor receiver of radio waves because its dimensions are so small that it cannot pick up much energy.

In Figure 2 is shown an antenna (erected on the roof of the Radio Building at the Bureau of Standards) which is used for receiving from radio telephone broadcasting stations. The antenna is 115 feet long and 18 feet above the roof. The lead-in wire (shown at the right end) is 45 feet long and passes down the far side of the building, and then through a window. The resistance of this antenna was measured first with a ground connection made to a gas pipe (inside ground), and then with a ground connection made to a pipe driven into the ground (outside ground) directly below



A DELICATELY CALIBRATED VARIABLE CONDENSER

FIGURE 1: *Here is shown a standard variable condenser which has been taken out of its protective casing. By rotating the black lever the rotary plates telescope inside of the stationary plates and the capacity of this instrument is varied. This instrument is used in the phantom antenna which is shown at B in Figure 1.*

the lead-in wire. The measurements were repeated with a single wire in the horizontal part of the antenna. The other constants were measured with the inside ground only as the particular kind of ground connection would make little difference. The results of these measurements are given below:

RESISTANCE WITH INSIDE GROUND

At 1,110 Meters

14 ohms (two-wire antenna)
6 ohms (single-wire antenna)

At 400 Meters

34 ohms (two-wire antenna)
43 ohms (single-wire antenna)

At 360 Meters

45 ohms (two-wire antenna)
37 ohms (single-wire antenna)

RESISTANCE WITH OUTSIDE GROUND

At 1,110 Meters

(Not measured for two-wire antenna)
16 ohms (single-wire antenna)

At 400 Meters

22 ohms (two-wire antenna)
23 ohms (single-wire antenna)

At 360 Meters

28 ohms (two-wire antenna)
17 ohms (single-wire antenna)

CAPACITY WITH INSIDE GROUND

0.00053 microfarad (two-wire antenna)
0.00038 microfarad (single-wire antenna)

FUNDAMENTAL WAVELENGTH

230 meters (two-wire antenna)
190 meters (single-wire antenna)

INDUCTANCE

25 microhenries (two-wire antenna)
22 microhenries (single-wire antenna)

These results show that the resistance of an antenna varies with wavelength, and that at the shorter wavelengths it was reduced by using a single-wire antenna with an outside ground connection. Antenna capacity decreases as the wavelength increases, and then becomes approximately constant. The higher fundamental wavelength of the two-wire antenna is due to higher capacity and inductance as compared with a single wire.

How may one determine the constants of an antenna?

Resistance can only be measured with special apparatus which is elaborate and expensive. It can *not* be computed. The other constants can be measured with less elaborate and, consequently, less expensive apparatus. It is also possible for one who owns a receiving set to measure these other constants with fair accuracy by adding a few simple pieces of apparatus. This method can not be described here, owing to lack of space.

Capacity can be computed, although in many cases it is necessary to make allowances for intervening objects, and other factors. On some antennas the computed capacity will check closely with that measured. In other cases the accuracy is not so good. In the formula

$$C = \frac{12.2\,h\,\sqrt{A} + 2.7\,A}{1{,}000{,}000 \times h} \quad \ldots(1)$$

C = capacity in microfarads
h = height of antenna above ground in feet
A = area of horizontal portion of antenna in square feet

To apply this formula to a single-wire antenna, A is obtained by multiplying the length of the nearly horizontal portion of the antenna by 2.5. The result obtained for C must be multiplied by a factor as follows:

Length of Antenna (In Feet)	Factor
30	1.12
40	1.16
50	1.2
60	1.24
70	1.28
80	1.32
90	1.36
100	1.4

Owing to conditions about the average receiving antenna, this result should now be increased by about 20 percent. The factor is not used when the antenna has more than one wire and in addition has a length less than eight times its width.

Fundamental wavelength in meters may often be accurately computed for a single-wire antenna by multiplying the total length of wire in feet by 1.37. Practical allowances can be made for an antenna of several wires close to obstructions, although the result will not be so reliable.

The inductance (L) of an antenna can not be accurately computed by a theoretical formula. It can be computed after one knows the fundamental wavelength (λ_0) and capacity (C), from the formula

$$L = \frac{\lambda_0^2}{3{,}550{,}000 \times C} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

If the reader has not the facilities for measuring antenna constants, he may determine them by applying the formulas just given.

To illustrate the method some typical antennas will be considered. The preceding formulas and the following examples apply to "L" antennas—the type used in the majority of cases. If the lead-in is taken from the center, the capacity remains about the same, but the fundamental wavelength is decreased.

Example 1:

A single wire 80 feet long and 40 feet high; lead-in wire is brought down vertically from one end. The antenna and lead-in are clear of obstructions. If the ground connection is good, the resistance of this antenna at 360 meters should not be more than 15 ohms.

To compute the capacity use formula (1) and let $h = 40$ and $A = 80 \times 2.5 = 200$. Substituting these values in formula (1)

$$C = \frac{12.2 \times 40\,\sqrt{200} + 2.7 \times 200}{1{,}000{,}000 \times 40}$$

$$= 0.000186$$

This value is multiplied by the factor 1.32 giving

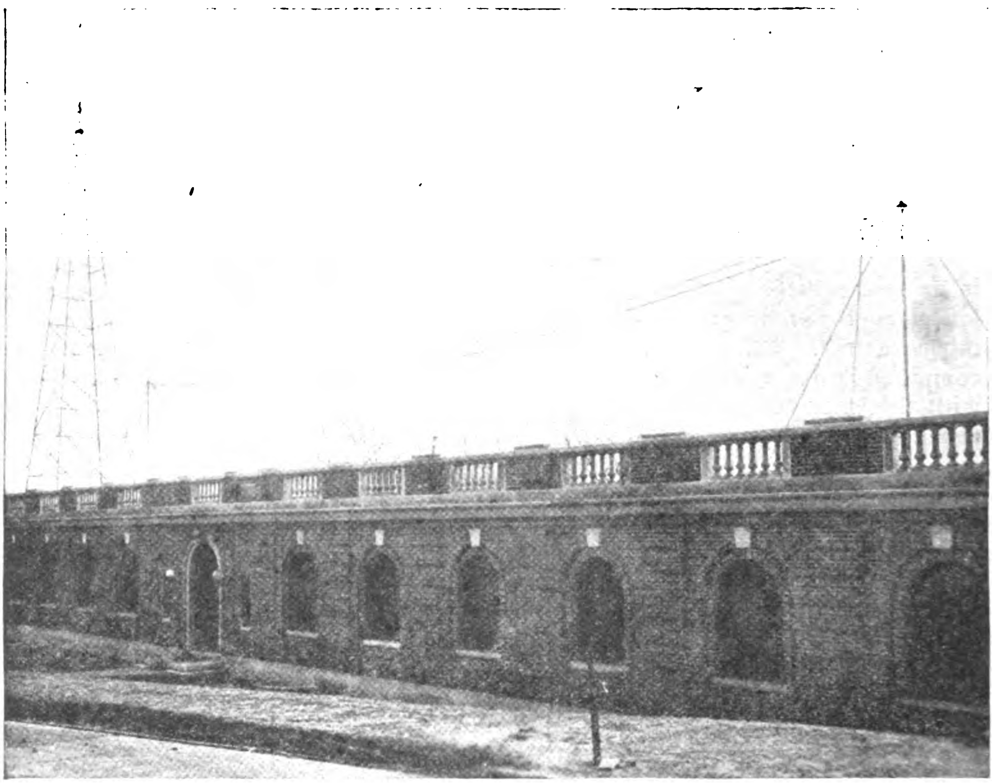
$$C = 0.000245$$

increasing the value 20 percent gives

$$C = 0.000294 \text{ microfarads}$$

If the antenna is close to trees or obstructions, or if the lead-in is closer than one foot from the building, the capacity will be increased still more.

The total length of wire (vertical and horizontal) in this antenna is 120 feet. Multiplying this by 1.37 gives 165 meters as the fundamental wavelength. Add 10



WHERE UNCLE SAM TESTS AMATEUR AERIALS

FIGURE 2: *A special two-wire testing antenna used by the Bureau of Standards in Washington. This is of the inverted L type, and was used for making the determinations explained in this article.*

percent to this value if the antenna or lead-in is close to obstructions.

Inductance is computed from formula (2) and is:

$$L = \frac{(165)^2}{3{,}550{,}000 \times 0.000294}$$
$$= 26 \text{ microhenries}$$

The same method of computation may be applied to single-wire antennas of various heights and lengths.

Example 2:

A two-wire antenna 40 feet long and 50 feet high with the wires three feet apart; the lead-in wire is brought down vertically from one end. With a good ground connection the resistance of this antenna, if it hangs clear in space, should not be more than 10 ohms at 360 meters. Because of its comparatively short length this type of antenna is likely to be erected in a restricted space. In this case its resistance may be increased two or three times. The capacity is computed as before, using A = 40x3, and is found to be 0.000192 microfarads. (If the wires are closer than 3 feet, the value of A is the same). Although the antenna has more than one wire, its length is greater than eight times its width; a factor of 1.16 is therefore used in obtaining the result. As before, buildings or obstructions which are very close will increase this capacity.

Multiplying the total length of wire (90 feet) by 1.37 gives 125 meters as the fundamental wavelength. This antenna has a capacity somewhat higher than if a single wire were used. The fundamental wavelength is thereby increased. To allow for this, increase 125 by 15 percent. This gives 145 meters for the fundamental wavelength. Again increase this value by 10 percent if obstructions are near. Inductance, computed as before, is 23 microhenries.

What is the best receiving antenna?

This is not an easy question to answer; in fact it can not be answered at all unless one knows the location of the antenna and the type of receiving set. If you have a receiving set with a regenerative tuner or one that employs some kind of radio frequency amplification it is not necessary to have a very high antenna; in some cases a high antenna may be a disadvantage. If you live in a part of the country where static is bad, a high vertical antenna (especially one of several wires) is undesirable. Instead, a single horizontal wire should be used. But if you have a receiving set with a simple (non-regenerative) detector and not more than one step of radio frequency amplification, it is well to have the antenna as high as possible, and also to keep it away from all obstructions. A receiving set connected in the ground lead close to the ground increases the effective height of the antenna and improves reception.

The following points apply irrespective of the kind of receiving set:

(1) Unless you are using an antenna near its fundamental wavelength or one which is exceptionally long compared to its height its directional effect will be slight and not worth considering.

(2) The antenna and lead-in should be kept as free as possible from swaying. The lead-in should be kept as far from obstructions as possible. The vertical part of an antenna is as important as the horizontal part. After the wire has entered the building, it must not be tacked to the wall.

(3) No. 14 copper wire is large enough for any ordinary receiving antenna and ground connection. Larger wire or stranded wire is better because it is mechanically stronger. Of course the greater the surface area, the lower the resistance, but in practice there are so many other features of resistance involved that a larger conductor than No 14 is not necessary. It makes no difference whether the wire is bare or insulated.

(4) All connections, especially those made outdoors should be soldered; this insures permanently low resistance. Ground connections to a pipe can best be made with a clamp; a clean surface for contact should be secured. It sometimes happens that a receiving station is situated where the soil is dry and where there is no natural ground connection; in this case a counterpoise (which is nothing but another antenna suspended near the surface of the ground, under the regular antenna) should be substituted. The counterpoise should consist of several parallel wires.

(5) Unless a high antenna is used, natural supports can usually be found. The ropes that support the antenna should have insulators inserted in them. Glazed porcelain is best, but oak blocks boiled in paraffin can be used.

(6) If the fundamental wavelength of the antenna is above 250 meters, a condenser connected in series with the wire leading to the receiving set should be used. If a fixed condenser is used its capacity should be about 0.0003 microfarad. To allow tuning to a wider range of wavelengths a special switch may be used in such a way that a variable condenser may be connected in series with the coil or shunted across the terminals.

(7) It is a good plan to take the lead-in from the center of the antenna instead of the end, when by so doing extra bends can be eliminated.

(8) A water pipe is a better ground connection than a radiator or gas pipe. An iron pipe driven several feet in *moist* earth may be used.

(9) A single wire will usually give as good results as several wires in the horizontal portion of an antenna. If space is limited, two or more wires may be used.

This article concerns antennas most effective in the reception of wavelengths between 200 to 450 meters.

From a photograph made for POPULAR RADIO

"FRANKLY, I CANNOT FOLLOW PROF. MORECROFT'S LINE OF REASONING"

In certain essential particulars, Mr. Benchley's conceptions of radio phenomena differ radically from Prof. Morecroft's. "At least," he states, "I am bound by no traditions or preconceived notions."

THE TRUTH ABOUT

The Heising Scheme for Modulation

—As I See It

A REMARKABLE COMMENTARY ON A REMARKABLE BOOK

By ROBERT C. BENCHLEY

DIRECTLY at the start of his "Principles of Radio Communication" (John Wiley & Sons) Prof. J. H. Morecroft falls into a regrettable error.

"Everyone is more or less familiar," he says in his opening sentence, "with elementary experiments having to do with electrically charged bodies."

This is obviously an overstatement.

I, for one, am not familiar to any degree at all with electrical experiments. I have never rubbed fur on a dry day, neither have I polished a glass rod with a cloth to induce it to attract bits of paper. I have had other things to do. Furthermore, I am quite sure, if one day I *did* have the leisure and the roving inclination to rub a glass rod with a cloth, that it would turn out to be the first glass rod in the history of electrical experiments which would *not* attract bits of paper. Rather than face this humiliation, I expect never to try.

Thus we see at the very beginning that Prof. Morecroft has generalized too freely. In this large manner he continues:

"It has been firmly established that every atom of matter is charged with minute particles of negative electricity, so-called *electrons.*"

All right, Prof. Morecroft, supposing

that I, as a doubter bound by no traditions, should say flatly that this is not so?

Suppose that I were to deny that every atom of matter is charged with minute particles of negative electricity and assert that, on the contrary, every atom of matter contains minute particles of fresh figs? What would you do about it? Bring a representative selection of atoms to my office on any day that you may chose and we will go over them, one by one, together!

Perhaps this is quibbling. I really don't know. However, I will string along with Prof. Morecroft from this point through his remarks on "Mutual Induction and Magnetic Coupling" (I thought there might be something spicy in that one, but there wasn't), "Decrement from Form of Resonance Curve" and "Reactance and Resistance of Parallel Circuits," and all without a protest. Not one word of it meant anything to me, so I see no use in protesting, even though I am quite certain that most of it is entirely wrong. It simply sounds wrong to me, that's all. I can't help how I feel, can I?

It is not until page 665, on which begins an analysis of the Heising Scheme for Modulation, that my blood boils and I am unable to control myself any longer. In the first place, I have no patience with all these new-fangled schemes for modulation. Why can't they let well-enough alone? As a matter of fact, this whole radio business, from start to finish, seems quite unnecessary. I was getting along all right before it was invented and I still manage to scrape along without knowing any more about it than I can help. If

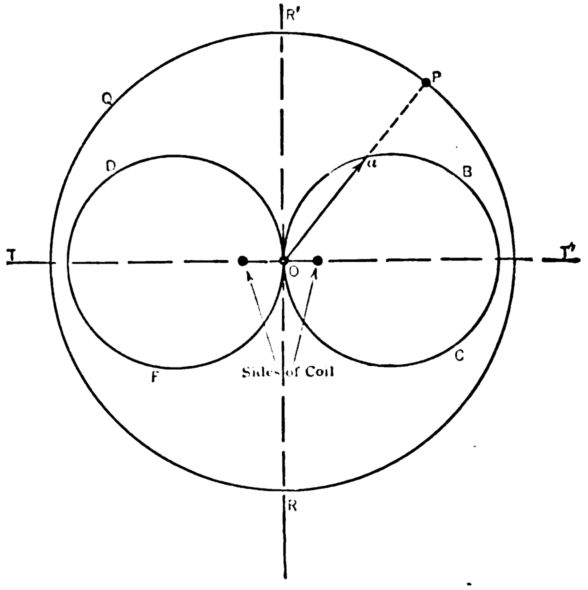


FIGURE 1

The above cut is taken from page 710 of Prof. Morecroft's book. For lack of a better caption we will call it "Full-face personality photograph of Common or Typhoid-Bearing House-Fly (magnified 1,000 times and even then it wasn't satisfied)." The reader will note, by following carefully the line T-T that not only has the static been done away with but that the fly can see just as well as it ever could, in fact, probably better. The food, entering at R, is carried by a special series of coils to F and C, where it waits twenty minutes for a connection with the train from South Framingham. Where Prof. Morecroft falls down is in supposing that the rim of the circle is going to run through P necessarily. According to the old plans, it would run eight miles to the north, which would make the Professor's chart look pretty silly. An odd thing about this figure is that, no matter in what part of the room you stand, the fly always seems to be looking at you and following you with his eyes. Try it and see.

I had my way, the whole thing would be stopped by law before someone gets hurt.

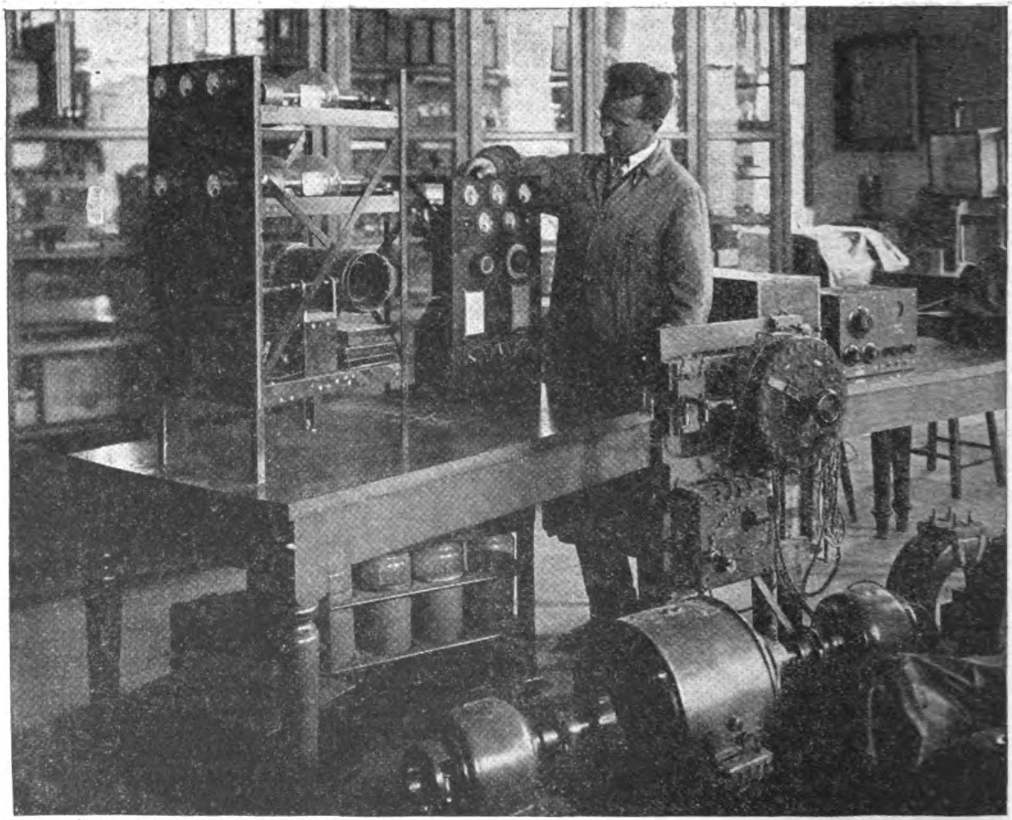
But this Heising modulation scheming strikes me as particularly pernicious. In order to understand it you have to refer to a picture on the opposite page which shows the number of yards gained in rushing by Yale in the first half and the number of yards gained by Harvard's punting in the second. Then there is, in the same picture, a good idea of what the dining-room groundplan will look like, with the stairs leading up out of it into the second floor. Also a cross section of the first bicycle blue-prints.

Working with this picture as a base, you assume (just for fun) that the microphone is actuated by a sine wave of sound, and *furthermore* (get this, now) that the sine wave of sound gives a sine wave of e.m.f. across the secondary terminals of the transformer S.

All right. That is assumed.

Now. In order that the possible variation in the impedance impudence of the grid-filament circuit of the modulating tube may not produce distortion of the terminal voltage of the transformer secondary, a high resistance R of constant value is permanently connected across the secondary to give the load circuit of the transformer an essentially constant impedance. That is, of course, provided that there are no other bookings for the hall on that night.

You can't make me believe, however,



From a photograph made for POPULAR RADIO

ONE OF AMERICA'S FOREMOST AUTHORITIES ON RADIO PHENOMENA

Prof. J. H. Morecroft of Columbia University, engaged in experimental work on vacuum tubes in his laboratory. He is the author of a book which is the subject of comment in the accompanying text.

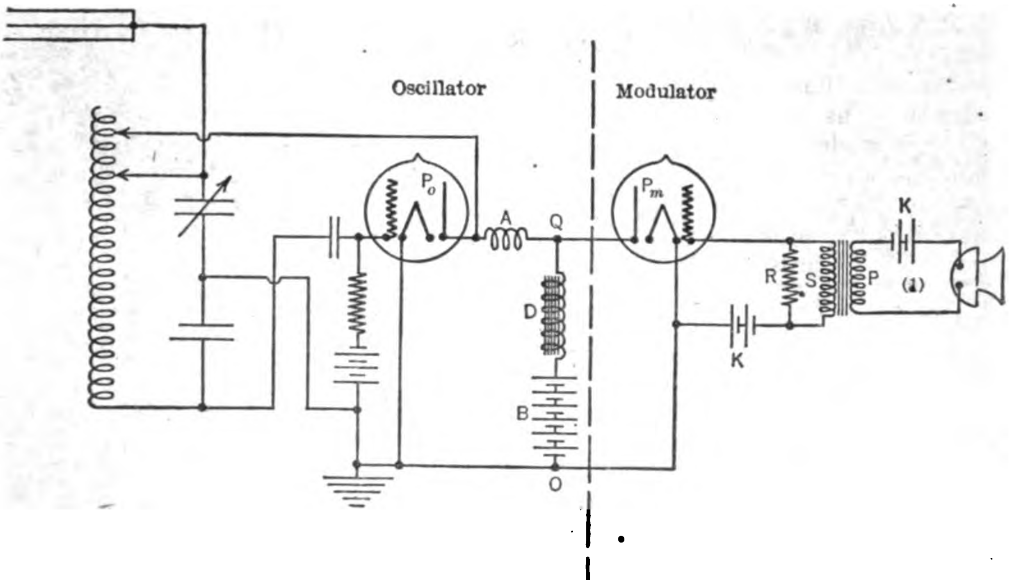


FIGURE 2

This graphic representation of the Heising scheme shows at a glance not only the number of yards gained by Harvard's punting in the second half of the football game, but also how the dining-room floor plan will look with the stairway and a cross section of the first bicycle blue-prints.

that it is as simple as all that. There is a catch in it somewhere. And here it is. Below we find:

Average value of I=0.08 ampere
Inductance of coil D=2 henries.

Now, of course, the ampere part is clear enough. And so is the "2 henries," for that matter, but it does seem as if Prof. Morecroft had picked a peculiarly unhappy place for kidding. Probably he would have liked to have gone on in the same vein:

Inductance of antenna=6 ralphs
e.m.f. vector=3 theodores
decrement of wave-meter=14 georges.

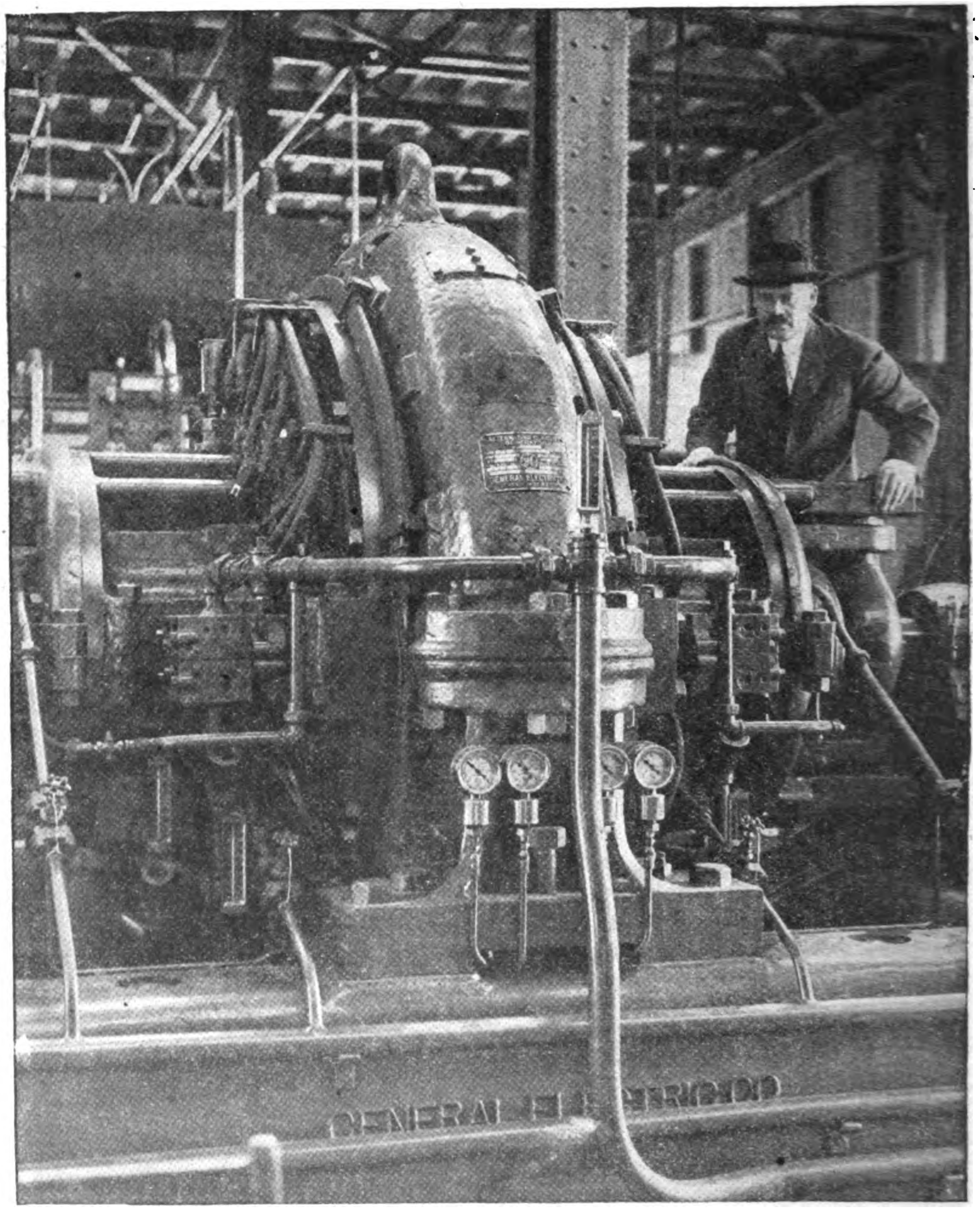
In a way, this flippancy is characteristic of the chief trouble with Prof. Morecroft's book. It is just kid, kid, kid, all the way through. Of course, we all realize that every subject, even radio, has its lighter side, but it does seem as if a professor in Columbia University might by this time be able to deal seriously and soberly for at least ten successive pages without recourse to gags and sure-fire laughs.

If you have a spare evening and want a good book to pick up and throw down, "Principles of Radio Communication" will suffice, but for solid instruction it is much too light.

ONE OF THE COMING FUNCTIONS OF AMERICAN UNIVERSITIES

"I am personally interested in the market of radio extension education, as I believe it to be one of the coming functions of American universities.

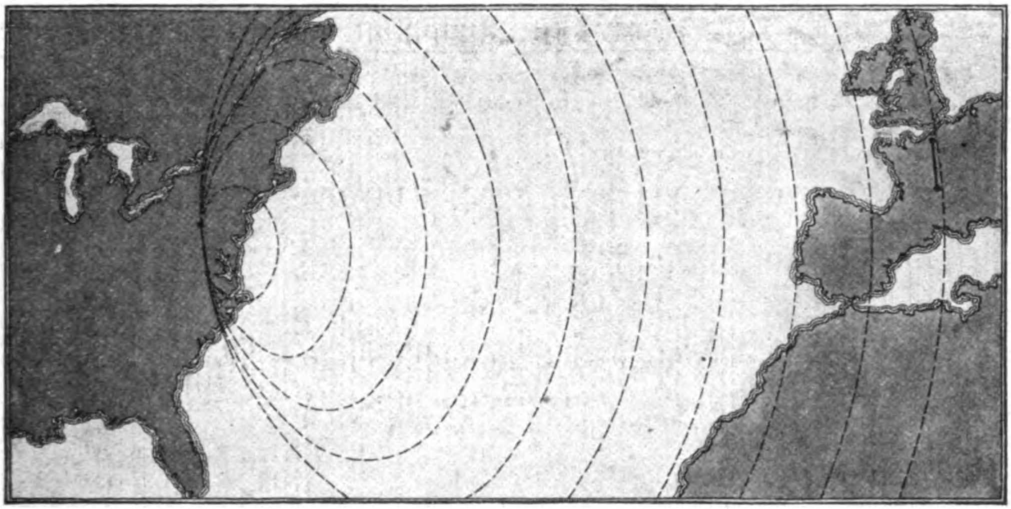
R. H. Goddard
Clark University



General Electric

This Mechanical Monster Produces
a 30,000-Meter Wave

The higher wavelengths used in transatlantic radio communication, ranging from 10,000 to 30,000 meters, are made possible by the power generated by this Alexanderson type of high-frequency alternator. Several of these whirling giants are used for energizing the antennas of the transmitting stations at Radio Central on Long Island, New York. Its inventor, Dr. E. F. W. Alexanderson, is here shown viewing his remarkable brain-child.



A PLAN FOR SPANNING THE ATLANTIC ON LOW POWER

At present transatlantic communication is carried on with high power on wavelengths up to 30,000 meters—waves which are inaudible. By using base-line antennas about 220 miles long this communication may be carried on at still longer wavelengths with waves that are *audible.*

THE COMING USE OF

Frequencies That We Can Hear

Experiments with audio frequency shows that its possibilities in "earth telegraphy" have scarcely been realized. Its application to the longer wavelengths is here pointed out.

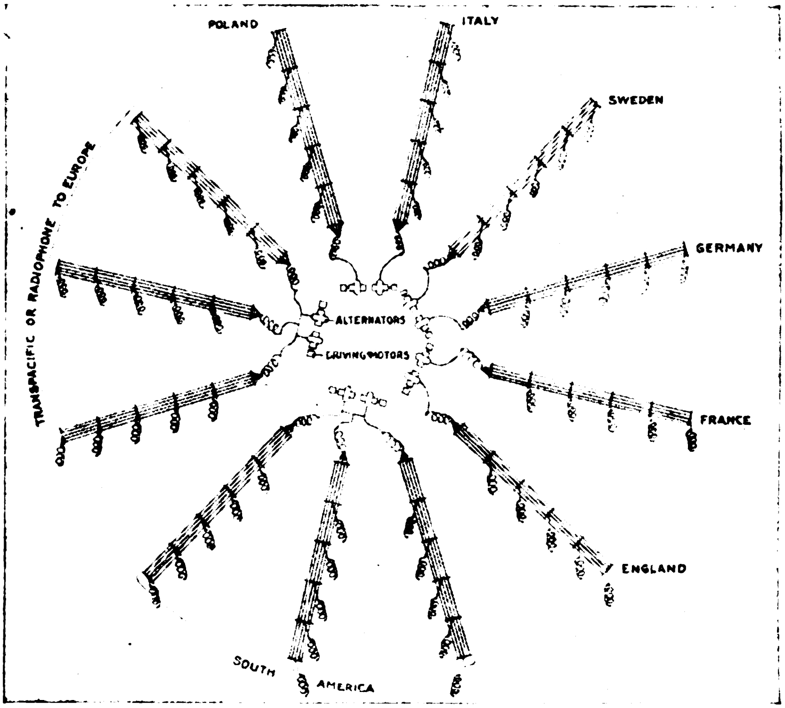
By OSCAR C. ROOS

THE temptation at the present moment is to ignore the field which modern high-power transmitting stations are approaching—the 30,000 meter wave and over; radio experimenters and the electrical world in general are directing their attention at present to very short waves. For that matter very short waves have been neglected for years; they have been used only occasionally as scientific tools in the laboratory, although Stone, Ladd and Marconi have used the shortest wavelengths—going down to two meters.

But the long wavelength—a wave, for instance, nineteen miles long which does not radiate until about five miles away from the station—is sure to be of interest.

The great drawback at present to the use of such waves is the fact that the radiant point, or rather cylinder, around a station allows less and less energy to flow out in the form of waves as the field gets weaker. The balance goes back to the antenna as the energy of a stationary wave, giving effects of distributed self inductance and capacity. This is the reason why power wires radiate very little energy at 60 cycles a second. The radiant cylinder for a vertical power wire under these conditions in New York would pass close to Atlanta, Nashville and Chicago—about 775 miles away. With such a weak field the radiation is immeasurably small.

It is worth while to dwell on the real meaning of the radiant cylinder. It is



Radio Corporation of America

A LONG WAVE ANTENNA SYSTEM

How the powerful high frequency alternators are connected to the multiple-tuned antennas at Radio Central. Most of the antenna systems are pointed in the opposite direction from the country with which they communicate.

a cylinder rather than a sphere, as relatively little energy is radiated vertically; and in any case the comparison is only intended to indicate that the greater part of the energy is traveling in a direction parallel to the imaginary plane touching the earth at the station. The use of the long wave creates problems of ground and dielectric losses which increase with the wavelength and are produced through direct induction by the stationary waves set up in the antenna system and in surrounding metallic systems, especially if there are any short waves produced in the form of harmonics.

It is more than probable that circuits in which the natural wavelength is many times as long as the greatest mechanical dimension, will be used in handling long waves; this has been done by Alexanderson and others with the multiple-tuned antenna. Most linear objects when oscillating have a wavelength between 2.1 and 2.5 times their dimensions; thus the difference in behavior of these two classes of circuits, used with proper amplifiers for receiving, opens a large field for experimentation.

It has been maintained by French engineers that the possibilities of audio frequency have not yet been realized in connection with "T. P. S.," or what is known as earth telegraphy. Judging from their work in the World War, an antenna ten miles long would give reliable communication under average conditions with another parallel to it—300 miles away overland.

Reasoning along these lines and bearing in mind the much less favorable conditions of transoceanic work, they believe that a ground antenna of about 220 miles in length, situated on the French coast, would provide excellent communication with a similar antenna in the United States.

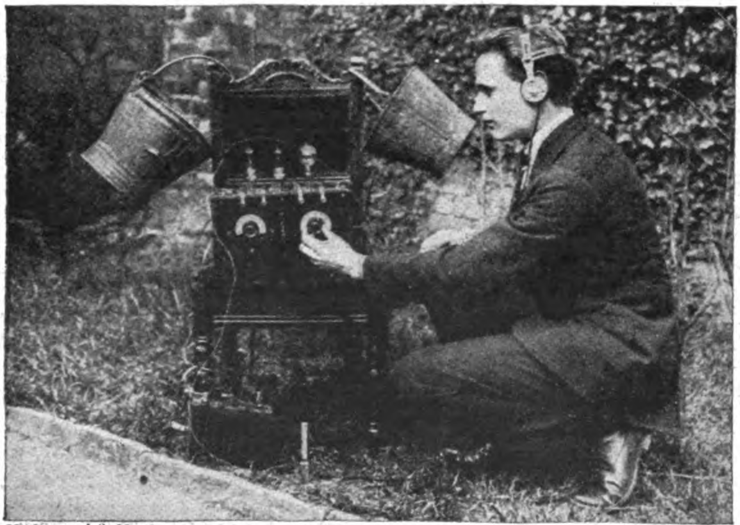
Such a system is illustrated on page 459. In this system the transmitting and receiving wires should be near the shore and arranged so as to be parallel, with the ends grounded. They would have the same natural frequency as the wave to be transmitted, and undamped waves would be used which could be heard without a detector to rectify them. The ratio of antenna length to range is now more than 50 on land, but would be less over the sea.

It has often been suggested that audio frequency waves be used commercially in "T. P. S." For the average person this would mean a wavelength greater than 30,000 meters, although many engineers can hear LY (the Lafayette station at Bordeaux) on a 6-stage radio frequency amplifier without a heterodyne. The ordinary telephone diaphragm can be made to vibrate at these high rates if the frequency coincides with the natural overtones of the diaphragm.

If audio frequency waves were used the detector tubes themselves might give out a note; the Lafayette station, at 22,100 meters, gives out a frequency of 13,630 cycles or about two octaves above the top note of the piano. The wavelength of this sound in air is about one inch, and one engineer in a testing station at Rockland, Maine, where signals were being measured, could hear these acoustic waves in a room twenty feet from the set.

The advantages of doing away with detectors and audio amplifiers are obvious. If the telephone for transforming sound to electric currents and *vice versa* could be replaced by a device which would have little or no mechanical inertia, the problem of reducing static by acoustic means to a negligible amount would be permanently solved and long distance radio communication at the longer wavelengths would be assured.

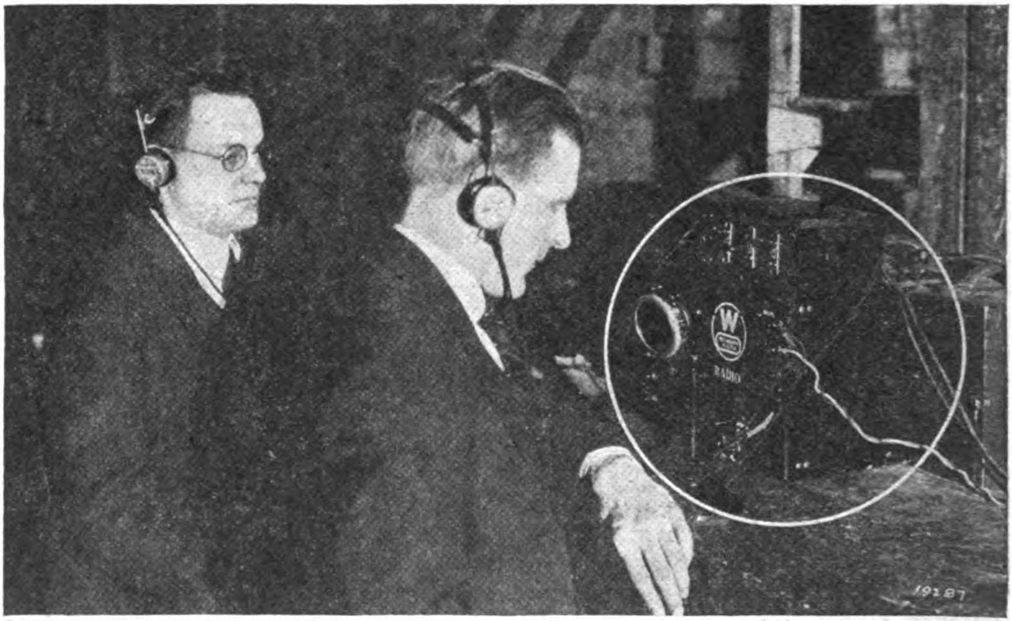
The use of such waves would call for the introduction of reliable mechanical relays, and if real rectifiers were combined with them and the heterodyne principle used to produce pulses at 10 to 100 a second, we could actually use tuned relays for recording the messages. This would minimize both static and interference to a large extent.



Underwood & Underwood

BAILING MUSIC FROM THE ETHER WITH A PAIR OF PAILS

A radio fan in Sheffield, England, has found that it is unnecessary to purchase a loop antenna as long as his garden is furnished with two ordinary tin pails. Using them as a literally "home-made" loop, he has had no trouble in picking up music broadcast from Manchester and London.



From a photograph made for POPULAR RADIO

THE "OFF STAGE" MEMBER OF THE CAST

In the wings—just out of sight of the audience—the announcer and listener carefully regulate the volume of the production as picked up by the microphones. In the circle is shown the pick-up speech amplifier box with the microphone switch box on top of it.

Wagner by Wireless

The broadcasting of grand opera by transferring the sounds direct from the stage to the transmitting station is developing into a real art. Practically all of the world's greatest opera companies are now broadcasting their performances—with the single exception of the Metropolitan Opera in New York. How it is being done and the effect that it is having on the attendance is here told.

By WILLIAM H. EASTON, PH.D.

THE opening performances of the heralded "Wagnerian Opera Festival," held at the Manhattan Opera House, New York, this spring, were poorly attended. Of course every Wagnerian devotee who could raise the price was there. But as the empty seats testified, the general public simply was not interested.

The management of the Festival was worried; financial disaster stared them in the face.

Then a sudden and remarkable change occurred.

On Monday morning of the second week, there was a riot around the box office. Thousands of people crowded in to buy seats. The management, entirely unprepared for such a state of affairs, had to summon the police to keep order. From then on, "standing room only" signs were hung out for each performance. The season which was originally planned to cover only three weeks was extended to seven weeks. A large proportion of the audiences consisted of those who were not familiar with Wagner, as was shown by their questions at the box office; while mail orders for seats poured in from points at long distances from New York.

What caused the change?

Simply this. On Saturday night of the first week, broadcasting station WJZ of Newark broadcast the performance by means of telegraph wire between the auditorium and the station* and continued to do so once a week thereafter as long as the season lasted. No better proof of the cultural value of broadcasting is possible. People not only enjoyed this superlatively good music as they heard it by radio, but they spent their money to hear more of it.

Those of the radio audience who could attend the operas in person did so; those who could not wrote to WJZ. Though the daily mail of this station is always large, it doubled and trebled during the opera season. The most interesting of the letters came from the Wagnerites who lived in remote places and had picked up the operas unexpectedly. Such an event to these people was a far more joyful surprise than the ploughing up of a pot of gold would be.

"As I was idly playing with my receiver last night," wrote a Canadian, "I tuned in a very fine soprano voice singing Elsa's Dream from *Lohengrin*. 'Good!' I thought. 'I wish they would give us more of that kind of music.' Suddenly something happened that made me jump to my feet. I heard trumpets

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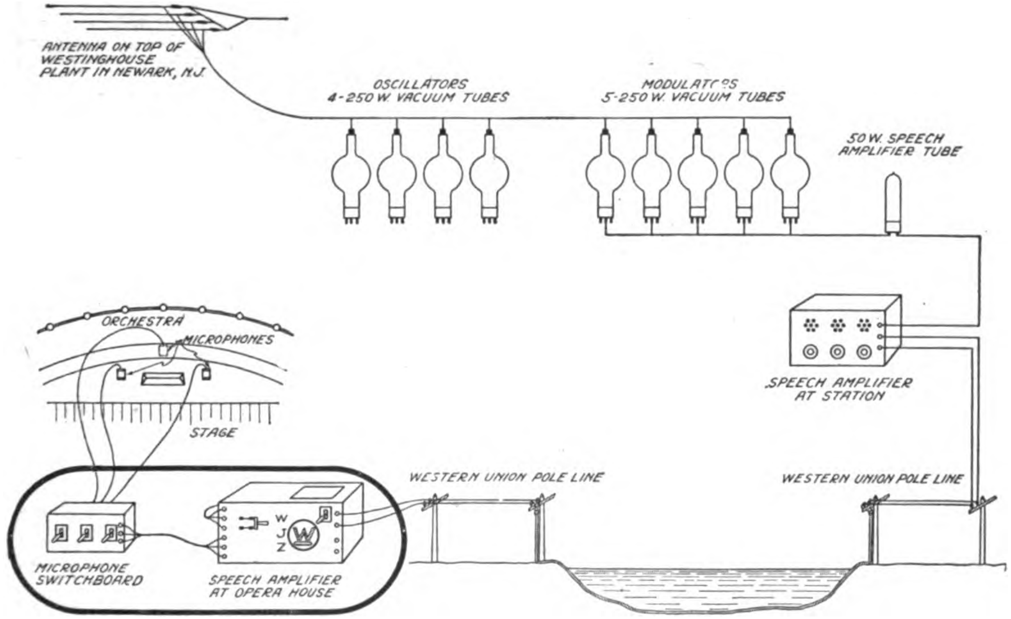
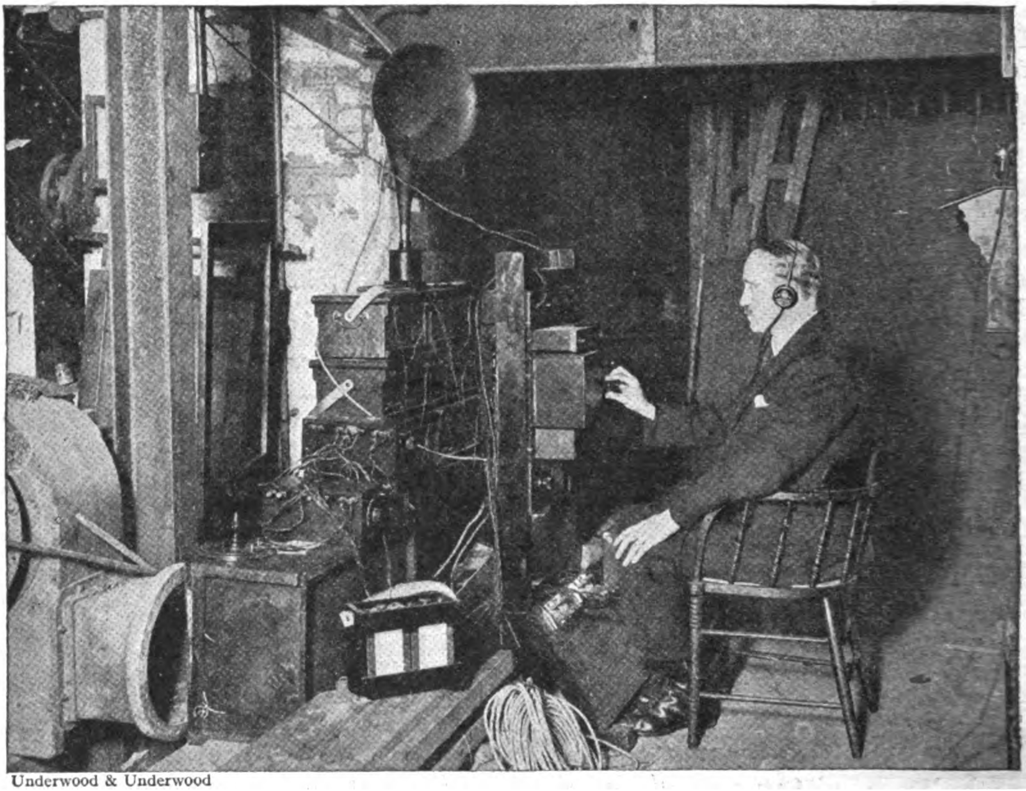
*How the technical difficulties of doing this were met was described in the article "Symphonies by Telegraph" in POPULAR RADIO of February, 1923.


ANTENNA ON TOP OF WESTINGHOUSE PLANT IN NEWARK, N.J.
OSCILLATORS 4-250 W. VACUUM TUBES
MODULATORS 5-250 W. VACUUM TUBES
50 W. SPEECH AMPLIFIER TUBE
ORCHESTRA
MICROPHONES
STAGE
SPEECH AMPLIFIER AT STATION
WESTERN UNION POLE LINE
WESTERN UNION POLE LINE
W J Z
MICROPHONE SWITCHBOARD
SPEECH AMPLIFIER AT OPERA HOUSE
SUBMARINE CABLE UNDER HUDSON RIVER

HOW THE MICROPHONE SWITCHBOARD AND AMPLIFIER ARE CONNECTED

The switchboard can pick out one particular microphone which is nearest the singer on the stage by merely "flipping a lever." The sounds picked up and converted into electric currents by the microphones are amplified to the correct volume by the apparatus in the speech amplifier box, and the amplified currents are sent over wires through the city, under the river on a submarine cable, up on the pole lines again and out to the station in Newark, where they are re-amplified a number of times and are used to control 5 quarter- kilowatt modulator vacuum tubes, which in turn control 4 quarter-kilowatt oscillator vacuum tubes, which furnish the radio frequency energy to the antenna system.



Underwood & Underwood

A PICK-UP AMPLIFIER BELOW THE STAGE

Here the operator and announcer listens in on a pair of receivers and controls the volume of pick-up, so that it is brought to the ears of the listening audience with the proper tonal values.

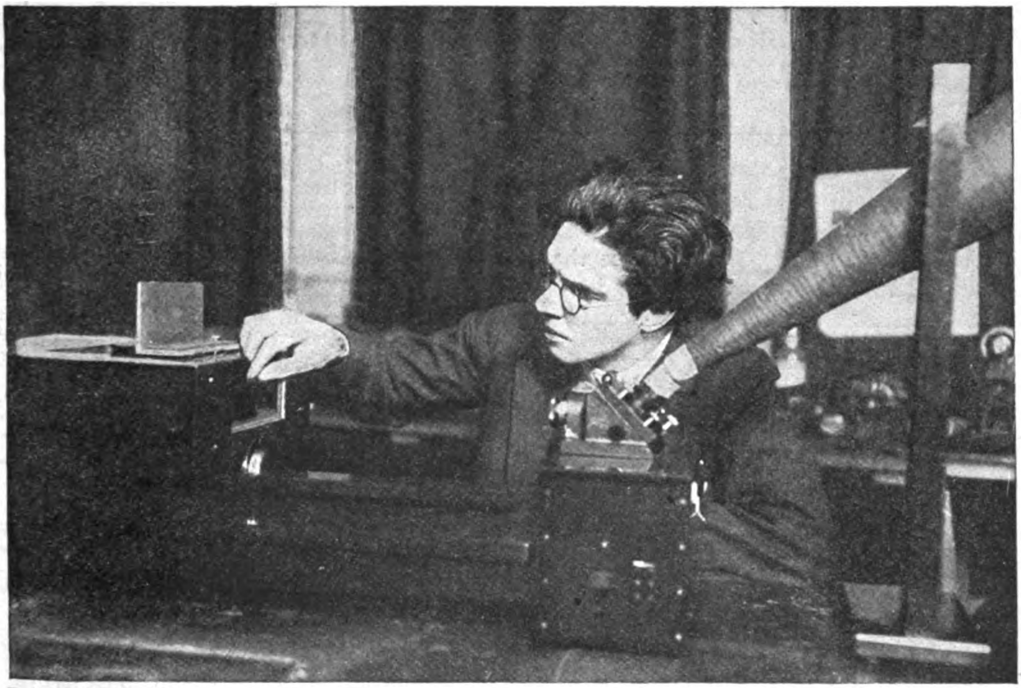
in the accompaniment! Was it possible that I was listening in to an actual performance of the opera? I held my breath in expectation until the chorus that follows the solo confirmed my hopes. I called my wife. She listened for a moment and then phoned excitedly to two musical friends. For the rest of the evening we four sat drinking in the superb music we had all heard so often years ago but hardly expected ever to hear again. Yet it came to us in these Canadian wilds, every note and every word of it. And the announcer tells us we are to hear more! How Wagner lovers all over the country must be thanking you!"

But many who had never heard Wagner before were hardly less enthusiastic. "I am an opera goer," wrote one, "but I have always intentionally dodged Wagner. Too highbrow for me! But from now on, it's Wagner for me!"

The average listener will, however, undoubtedly be at loss to understand this feeling. Wagner is more or less of an acquired taste, and his music-dramas rarely appeal to those who do not understand the dramatic action or the meaning of the music. But radio provides an ideal method of learning just these things. The next time a Wagnerian opera is broadcast, read in advance a Wagnerian handbook (which may be obtained from any public library or music house). This will give you the story of the opera you are to hear, and explain the themes which run through the music. These themes, each of which has a meaning, are for the most part simple melodies which can be played on the piano with one finger, but they are used by the composer to produce the most marvelous effects. Provide yourself also with a libretto of the opera (which can be obtained from music houses for twenty-five cents) or better yet, a piano score, which can be found in almost every public library. Thus equipped, you will be able to follow both the action and the music.

Technically, the broadcasting of the operas proved to be difficult. A perfect balance must be kept at all times between the orchestra and the voices, as they are equally important. But the powerful *fortissimos* of the full orchestra tended to drown out the singers; while the immense lung-power possessed by all Wagnerian singers tended equally to drown out the beautiful *pianissimo* passages of the orchestra accompaniment.

To add to this complication, the acoustics of almost all theaters are unsuitable for broadcasting; and unless special preventive measures are taken, there is invariably a blurring of the sounds due to echoes. Circumstances over which the broadcasting station had no control prevented preliminary experimentation, and its engineers had to trust to their best judgment in placing the microphones. In consequence, the broadcasting of the first operas was not all that could be desired, but the imperfections were carefully studied and steps were taken to eliminate them. By the time the fourth opera was sent out, however, everything was working smoothly, and in the judgment of competent critics the performances thereafter were remarkable achievements.



Dorien Leigh, London

AN INSTRUMENT THAT RECORDS AND ANALYZES SOUND WAVES

This apparatus, the invention of Prof. A. M. Low, of England, readily distinguishes sounds which are so much alike that the human ear cannot perceive their differences—one more instance where science has produced a machine more sensitive than the human organs of perception.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help* ***in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus.*** *If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry.*

QUESTION: What does the grid leak do in a vacuum tube receiver? I have never seen any explanation of what this instrument is for, but I notice that all sets seem to be provided with it.

ALBERT THOMAS

ANSWER: We take it for granted that you understand that it is the alternating negative and positive charges on the grid of the detector tube that cause the fluctuations of plate current that actuate the telephones. Briefly, when the grid is charged at a negative potential by an incoming impulse, this charge on the grid repels the negative electrons trying to cross from the filament to the plate; this causes a reduction in plate current. When the grid is charged with a positive charge the electrons from the filament are attracted strongly toward the grid and plate; this causes a great increase in plate current. When no signals are being received, the electron flow from the filament is continuously causing the grid to be charged negatively, and if this condition were to continue the plate current would eventually cease. To prevent this the grid leak is placed so that the negative charge on the grid may leak off when it becomes excessive. The resistance of the grid leak determines the maximum negative charge that can accumulate on the grid; when a charge tends to increase above the maximum value for the resistance that is used, the grid leak allows the excess to leak off. This keeps the free negative grid potential at the correct value for best operation as a detector.

* * *

QUESTION: I have a regenerative receiving set with which I have been able to pick up long distance stations from time to time. My worst trouble seems to be that my set oscillates too much. How can I cut this down?

J. B.

ANSWER: You may reduce the strong oscillation in your set by one of three methods: by not turning up the detector filament rheostat quite so high; by using a lower plate voltage on the detector tube; or by using a grid condenser of a lower capacity.

Question: What is the proper resistance for a potentiometer used with the radio frequency amplifier to stabilize the grid circuits?

F. B. Lozier

Answer: A potentiometer of 200 to 300 ohms resistance will be best. This high resistance will allow only a small flow of current from the "A" battery and will *not* run it down perceptibly.

* * *

Question: What is the correct voltage for a "B" battery to be used on the plate of the detector tube for long distance reception?

L. Johnson

Answer: This depends upon the type of tube you are using. With a soft detector tube, 16½ to 22½ volts on the plate will give the best results. In that case, use a tapped "B" battery and test out the set on distant signals with different voltages between these two values until the best is found. For extremely loud signals from local stations it is best to use a hard tube, with about 90 volts on the plate. This will give a great deal of strength. It is not good for weak signals, however, as the tube is too unstable and will burst into oscillation. When a hard tube is used for distance, it is best to use 22½ to 45 volts on the plate.

* * *

Question: Please give me a diagram of a simple reflex circuit for one tube and a crystal detector. Let me know also what instruments I will have to obtain to construct the set.

C. G. Roos

Answer: A circuit is shown in Figure 1 which will be suitable for you to use. The parts used in the set are as follows:

L1 and L2—primary and secondary windings of a variocoupler;
VC—variable condenser, .0005 mfd.;
AFT—audio frequency amplifying transformer;
RFT—radio frequency amplifying transformer;
R—rheostat, 5 ohms;
Det—crystal detector;
C1—fixed condenser, .0005 mfd.;
C2—fixed condenser, .0005 mfd.;
Tel—head telephones, 3,000 ohms.

The set is tuned in the ordinary manner and the crystal adjusted to the most sensitive spot.

* * *

Question: Are 201-A vacuum tubes suitable for use in my super-regenerative set that I built according to the specifications in the November issue of Popular Radio? At present I am using Western Electric tubes, but they are getting old and I want to be prepared to replace them.

Leroy Hetzel

Answer: The new 201-A vacuum tubes which take but a quarter of an ampere of current for the filament are exceptionally well suited for this use; they will give just as good results as the tubes you now use.

* * *

Question: I have a small set. Would it be best to use a pair of telephones attached to a horn or a regular loudspeaker?

J. A.

Answer: A loudspeaker would be best.

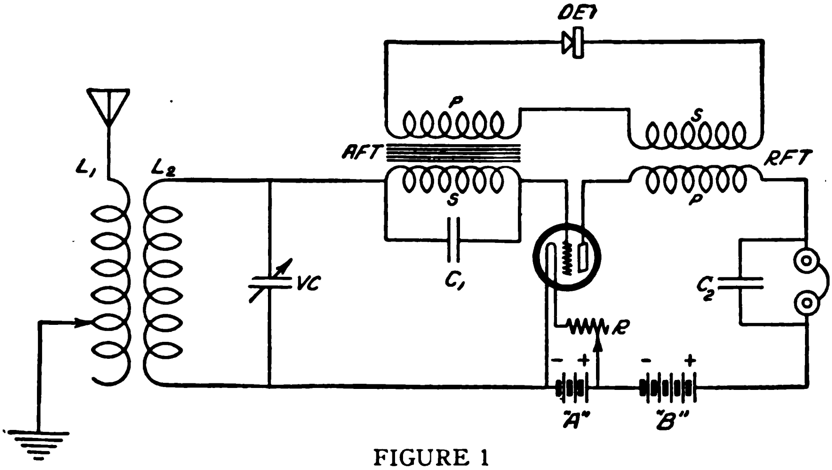
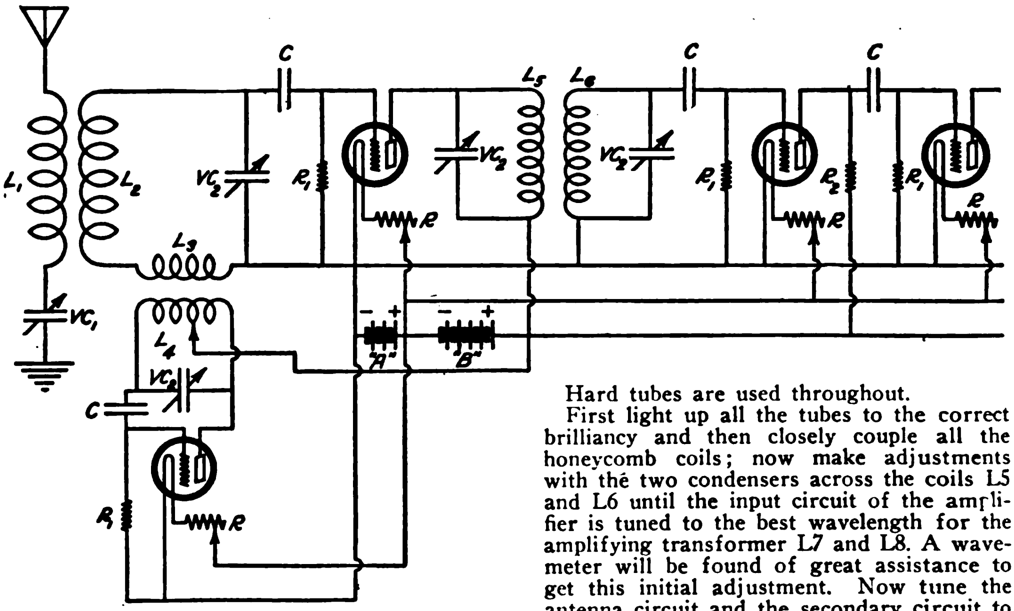


FIGURE 1

A simple reflex set with one tube and a crystal detector.



Question: Please show me a hook-up of an Armstrong super-heterodyne receiver that uses three stages of resistance-coupled radio frequency amplification and two stages of audio frequency amplification. I would like also a list of the special parts needed to build such a set and any other information that will help me. I have built quite a few sets which embody numerous hook-ups and have had good results on the whole, but I have heard that this is the best and most selective circuit there is.

Lee Bartindale

Answer: An eight-tube super-heterodyne circuit is shown in Figure 2. The designations on the diagram refer to these parts:

L1—honeycomb coil, L-35;
L2—honeycomb coil, L-50;
L3—honeycomb coil, L-25;
L4—honeycomb coil, L-50;
L5 and L6—honeycomb coils, L-300;
L7 and L8—primary and secondary coils of radio frequency transformer that have 3,000 to 5,000 meters range;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
C—mica fixed condenser, .0005 mfd.;
C1—mica fixed condenser, .001 mfd.;
R—rheostats, 5 ohms;
R1—grid leak, 2 megohms;
R2—resistance unit, 100,000 ohms;
AFT—audio frequency transformers.

Hard tubes are used throughout.

First light up all the tubes to the correct brilliancy and then closely couple all the honeycomb coils; now make adjustments with the two condensers across the coils L5 and L6 until the input circuit of the amplifier is tuned to the best wavelength for the amplifying transformer L7 and L8. A wavemeter will be found of great assistance to get this initial adjustment. Now tune the antenna circuit and the secondary circuit to the correct wavelength by means of the condensers VC1 and VC2, and rotate the condenser VC2, which is connected across the coil L4. At two adjustments of this condenser, the static and signals will come in loudly. Finally loosen the coupling between L5 and L6 and re-tune with the two variable condensers of that circuit until the signals are strengthened and clarified. Adjustment of the filament currents may now be made, and for changes in wavelength the only other variables will be the primary and secondary condenser and the heterodyne condenser.

If a loop is to be used with this circuit it may be connected in place of the coil L2. In this case the outdoor antenna, the coil L1, and the antenna tuning condenser VC1 will be eliminated.

* * *

Question: Is there any type of loud-speaker that does not use a horn? If so, how does it work?

C. H. G.

Answer: There is one manufacturer who makes a loudspeaker that propagates sound waves in free air directly, without the use of a megaphone, horn, or other acoustic amplifier. This is made possible by the use of a large flexible diaphragm, conical in form and made of paper, which produces sound waves that correspond substantially in relative amplitude as well as in pitch to the original sound waves. It is claimed that the distortion which is usually found in a horn, where violent air disturbances are generated in a confined space, is eliminated with this instrument.

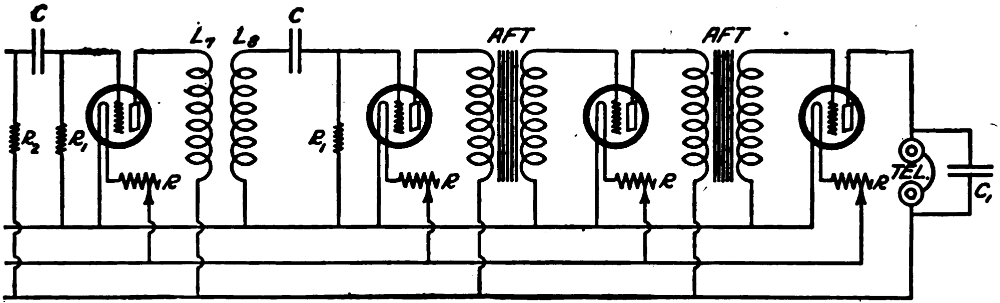


FIGURE 2
The famous Armstrong super-heterodyne receiver; it uses two detector tubes, one oscillator tube, three radio frequency and two audio frequency amplifier tubes.

QUESTION: What is the correct capacity for a variable condenser in series with the primary coil of my vario-coupler and for a variable condenser across the secondary coil of my vario-coupler? I want to have a tuning range of from 200 to 500 meters so that I will be able to tune in both amateur and broadcasting stations.

CHARLES STEWARD

ANSWER: The variable condenser in the primary circuit should have a capacity of .001 mfd.; the variable condenser shunted across the secondary should have a capacity of .0005 mfd. and should have a vernier attachment for fine tuning.

* * *

QUESTION: What kind of wire should I use in my receiving antenna?

J. J. AMES

ANSWER: Seven-strand No. 14 copper wire is best. Solid wire of the same size may be used, but the greater surface of stranded wire makes it give better results.

* * *

QUESTION: Please send me a diagram of a regenerative single-tube circuit that will not be seriously affected by body capacity while it is being tuned.

A. CROMWELL

ANSWER: The circuit is shown in Figure 3. The antenna circuit is tuned by the tapped coil L, and the variable condenser VC1 which has a capacity of .001 mfd. The secondary circuit is tuned by the variable condenser VC2, .0005 mfd. and the variometer Var1, and the regeneration is controlled by the variometer Var2. The rotary plates of the condenser VC1 should be attached to the ground wire. GL is a grid leak of 2 megohms, and GC is a mica fixed condenser of .00025 mfd. capacity. The bypass condenser C should be of approximately .001 mfd. capacity.

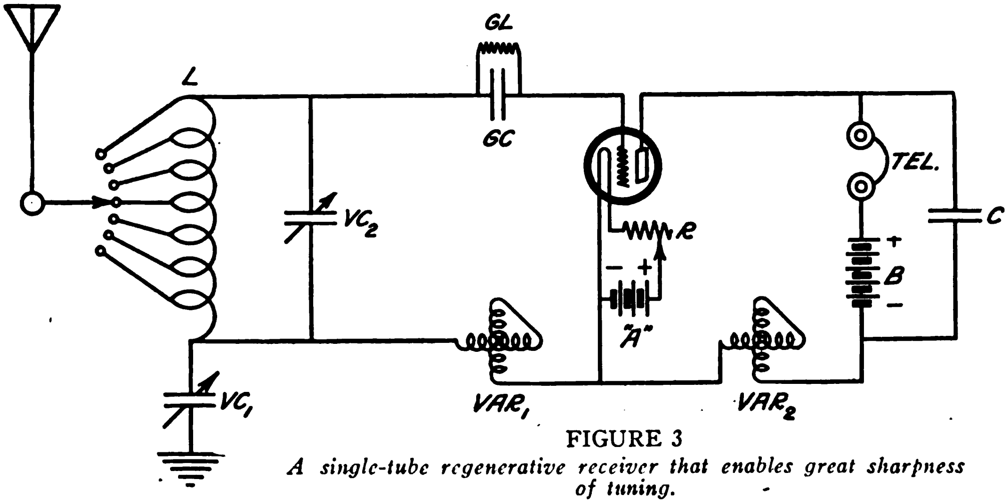


FIGURE 3
A single-tube regenerative receiver that enables great sharpness of tuning.

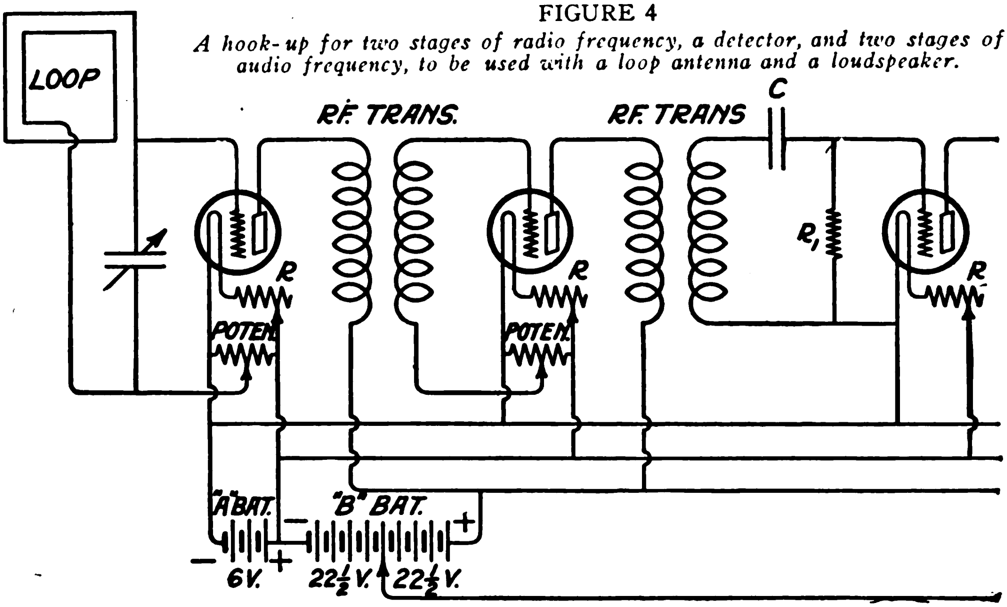


FIGURE 4

A hook-up for two stages of radio frequency, a detector, and two stages of audio frequency, to be used with a loop antenna and a loudspeaker.

QUESTION: Please draw a diagram that shows how to connect the following instruments so as to have two stages of radio frequency amplification and two stages of audio frequency amplification with a vacuum tube detector:

1 loop antenna;
4 amplifying tubes;
1 detector tube;
5 rheostats;
2 potentiometers;
"A" and "B" batteries;
1 grid condenser, .0005 mfd.;
1 grid leak, 2 megohms;
1 Western Electric loudspeaker, type 10-D;
2 G. E. radio frequency transformers;
2 All American audio frequency transformers;
1 Federal jack;
1 variable condenser, .0005 mfd.

Please show clearly what to do with the potentiometers.

ROBERT DENTON

ANSWER: In Figure 4 you will find the proper circuit for connecting these instruments. The potentiometers are used to keep the grid at a correct negative potential that will permit the greatest amplification possible without oscillation in your tubes. We have shown a tap on the "B" battery; this will allow you to use a soft tube for the detector if you so desire. You did not state what size loop you intended to use; we advise a loop three feet square wound with 12 turns of wire spaced ¼-inch.

* * *

QUESTION: Can I mount one stage of audio frequency amplification on the left-hand side of my receiving set and the other stage on the right-hand side? This will give my set a balanced appearance and will improve its looks greatly.

A. F. CLARK

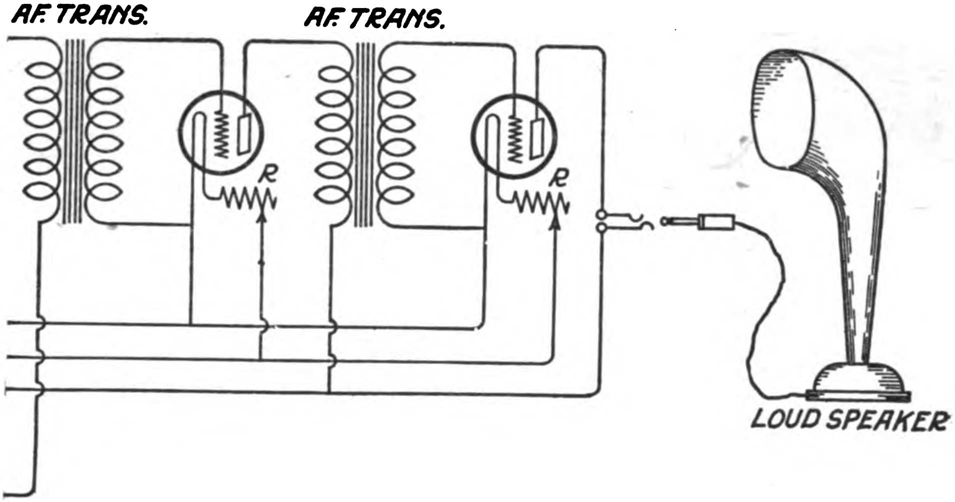
ANSWER: This would not be advisable. The audio frequency apparatus should be grouped together and the radio frequency apparatus should be grouped together. A good arrangement is to place the tuning instruments at the left of the panel, the detector in the center, and the audio frequency apparatus at the right. Never place the amplifying transformers near the tuning apparatus; the iron cores will be certain to cause loss of tuning efficiency.

* * *

QUESTION: I want to add radio frequency amplification to my set for "DX" reception. I have a loop antenna. What is the least number of stages I should use?

HARRY KANE

ANSWER: Use at least two stages. This will bring in local stations with good volume and clarity; at the same time it will amplify the "DX" enough.



QUESTION: Please give me a hook-up showing how to add one stage of radio frequency amplification to the circuit shown in Figure 4, on page 212 of the November issue of POPULAR RADIO.

AUSTIN FARMER

ANSWER: The diagram in Figure 5 gives you the information you require. The extra parts needed for this hook-up are as follows:

R1—filament rheostat;
1—hard vacuum tube;
P—potentiometer, 200 to 300 ohms;
RFT—radio frequency amplifying transformer;
2—"B" batteries, 22½ volts each;
C—fixed telephone condenser.

The tuning of the set will be by the same procedure as before the amplification was added.

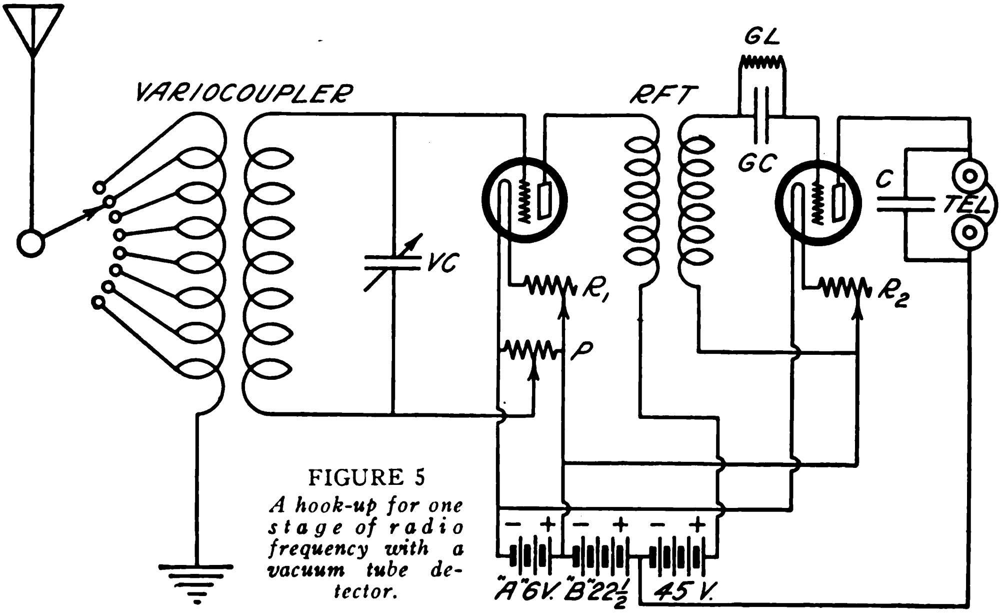


FIGURE 5
A hook-up for one stage of radio frequency with a vacuum tube detector.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

The New Broadcasting Schedule

TO divide the entire United States into fifty districts and to give each a first-class broadcasting station with sufficient power to completely cover that district:

To assign a band of wavelengths all the way from *220 meters to 545 meters for broadcasting purposes* to be distributed among the stations:

That, in brief, is the major benefit resulting from the Conference of the National Radio Committee in Washington which ended on the 24th of March.

Previously, most of the 500 broadcasting stations in the United States were concentrated around the three wavelengths 360, 400 and 485 meters. As a result of the most recent recommendations it will now be possible to assign to the majority of stations individual wavelengths and to divide the stations into two classes.

The most powerful stations will be in Class "B" and will embrace stations formerly in Class "A" and Class "B."

The new Class "A" stations will have an output up to 500 watts in the antenna and will use wavelengths between 222 and 286 meters.

The new Class "B" stations will have an output between 500 and 1,000 watts in the antenna and will use wavelengths between 300 and 545 meters. These stations are subjected to special regulations to insure the quality and continuity of their program.

Class "C" stations will be stations who wish to continue on 360 meters. No new Class "C" licenses will be issued.

By "staggering" stations over the country, it will be easily possible to continue broadcasting without the discouraging interference now experienced.

During the recent hearing, the writer brought out the fact that 90 percent of telegraphic interference which broadcast listeners experience results from American-owned or controlled ship stations, on wavelengths around 450 meters. In line with this observation the use of the 450 meter wavelength by ship stations is to be abolished between 7.00 and 11.00 P. M., local standard time. At the same time every effort is to be used to get the companies concerned to alter the adjustment of their equipment in order that the traffic which is now handled on 450 meters may be shifted to wavelengths between 700 and 800 meters, a band of wavelengths having been secured in this zone through relinquishment of seldom used wavelengths previously reserved for the use of government stations.

Provision is also made for a new field of radio telephone service—ship to shore service—which would enable persons on shore to talk to those aboard ships. This correspondence will take place between 800 and 952 meters and between 1,053 and 1,277 meters.

It has also been decided that the reading of telegrams or letters by broadcasting stations should be permitted, providing the text matter is of general interest, and so long as the signer of the letter or telegram is not addressed in person. Also that the rebroadcasting of a program from distant stations is to be permitted as a service only on a broadcasting wavelength and with the authorization of both the original broadcaster and the Department of Commerce.

The present scheme differs in many respects from that one outlined by the Radio Committee a year ago, in that no provision for broadcasting on wavelengths above 600 meters is made. As is quite generally known, the absorption, reflection, and refraction of radio waves of the higher frequencies (600 meters and below) is very marked. The effects are generally termed as due to "freaks" or to "fading." There are many less thickly populated sections of the country which might perhaps be better served if the broadcasting were done on wavelengths above 1,000 meters due to the comparative absence of the transient phenomena mentioned above. But, it must be said that considering the extreme complexity of the problems to be solved, the Radio Conference has accomplished some very important results and all who are interested should feel no hesitancy in giving credit where credit is due.

PAUL F. GODLEY

Pacific and Atlantic

THE EXPERTS WHO RE-ARRANGED THE WAVEBANDS FOR BROADCASTING

In order to meet the emergency created by the failure of Congress to pass the White Radio Bill, and to establish temporary measures that may bring order out of the confusion caused by 580 broadcasting stations, Secretary Hoover called upon these men for advice. Here are some of the advisors (left to right): C. Francis Jenkins, Paul F. Godley, Hiram Percy Maxim, F. H. Schnell and Major General George O. Squier—all contributors to POPULAR RADIO.

Cities Get Special Wavelengths

ONE of the immediate results of the recent conference of radio experts in Washington was the allocation of special wavelengths to broadcasting stations of the Class B group by cities—a system that promises to establish the whole broadcasting situation on a basis that will be greatly to the advantage of all concerned. The real significance of this step will be described in POPULAR RADIO by John V. L. Hogan, in a following issue.

ZONE 1

City	*Wavelength in Meters*
Springfield, Mass. Wellesley Hills, Mass.	337
Schenectady, N. Y. Troy, N. Y.	380
New York City and Newark, N. J.	405 455 492
Philadelphia, Pa.	509 395
Washington, D. C.	435

Reserved: 303, 319, 469, (357), (288).

ZONE 2

Pittsburgh, Pa.	326
Chicago, Ill.	448
Davenport, Iowa Des Moines, Iowa	484
Detroit, Mich. Dearborn, Mich.	517
Cleveland, O. Toledo, O.	390
Cincinnati, O.	309
Madison, Wis. Minneapolis, Minn.	417

Reserved: (294), 345, (366).

ZONE 3

Atlanta, Ga.	429
Louisville, Ky.	400
Memphis, Tenn.	500
St. Louis, Mo.	546

Reserved: 300, 316, (353), 375, 462, 333.

ZONE 4

Lincoln, Neb.	341
Kansas City, Mo.	411
Jefferson City, Mo.	441
Dallas, Tex. Fort Worth, Tex.	476
San Antonio, Tex.	385
Denver, Colo. *(Reserved)*	323
Omaha, Neb.	527

Reserved: (361), (291), 306.

ZONE 5

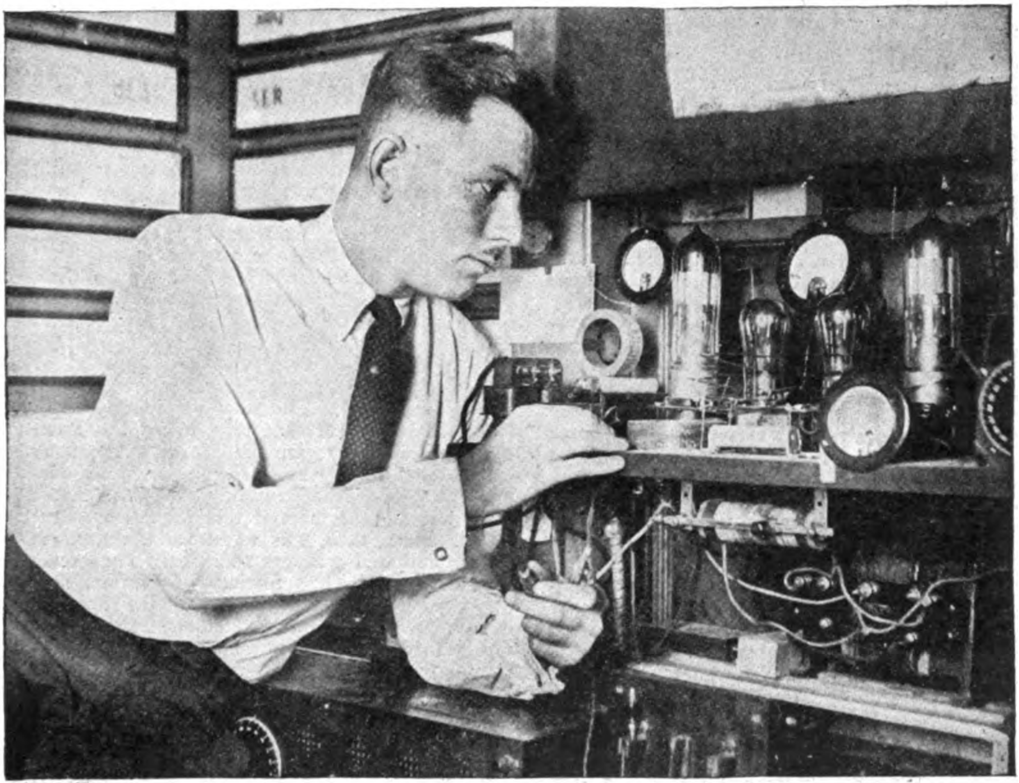
Seattle, Wash.	492
Portland, Ore.	455
Salt Lake City, Utah	312
San Francisco, Cal.	509 423
Los Angeles, Cal.	395 469
San Diego, Cal.	536

Reserved: (297), 330, (349), (370).

Fotograms

LESSONS FROM A LOUDSPEAKER

Just to show that classes in school may be conducted by radio—perhaps in many schools simultaneously—the Haaren High School in New York recently staged a demonstration during which problems were transmitted from WJZ, and the answers were given after a proper interval, so that the pupils could check up their work.



Kadel & Herbert

THE BEST AMATEUR SENDING AND RECEIVING SET IN THE COUNTRY

Once a year the Hoover cup is awarded by the Department of Commerce to the radio amateur who owns the best apparatus for both transmission and reception and the major portion of which is home-made. The award for 1922 has just been given to Frederic R. Ostman of Ridgewood, N. J., whose call letters 2OM will be recognized by the amateurs throughout the country.

How Broadcasting Is Getting Started in England

A QUARTER of a century and more ago, when "wireless" was a term that was known to only a small group of experimenters, Mr. A. Frederick Collins was demonstrating successfully his first radio apparatus. It is of particular interest, therefore, to learn from such an experienced old timer of the present beginnings of the popular interest in broadcasting in England. Mr. Collins writes from the Authors' Club of London:

Broadcasting has been in the melting pot for the past year but it has now been poured out into a bright, concrete ingot. This long-desired and highly satisfactory result is due, primarily, to the efforts of the amateurs who were members of the Wireless Society of London, but whose scope has recently been extended to include all of the other amateur wireless organizations of Great Britain and which are now included under the name of the Radio Society of Great Britain.

The Wireless Society of London was organized ten years ago at the home of a well-known amateur, René H. Klein, of West Hempstead, who originated the idea of it. He had the foresight to realize that there was bound to develop more or less friction between the amateurs and the Post Office* authorities, unless some sort of co-operation could be established between them.

A few months later the society was expanded to include all the other local wireless clubs which were then springing up all over the country. A number of workers who stood high in the art of wireless were chosen Vice-Presidents and from these a President was elected—Mr. A. A. Campbell Swinton,

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*The Post Office controls all forms of communication in Great Britain.

F. R. S., who held the office for a period of seven years, although for four of these the society was in a state of suspended animation due to the war.

But between the time of its organization and Great Britain's entry into the war, a large number of the best type of wireless amateurs had enrolled as members of the society. In those early days apparatus for sending or receiving was not so easily made or procured here as it is now. Few amateurs owned their own sets; instead, a number of them would club together, hire a room, install the apparatus and own and operate it jointly. In this way the members of the Wireless Society of London raised a fund, bought a wireless set and installed it in a clubroom that was open to members. At the beginning of the war the aerial had to be taken down and the apparatus was officially sealed, but classes in the Morse code were held and expert advice was given to all members who wanted it.

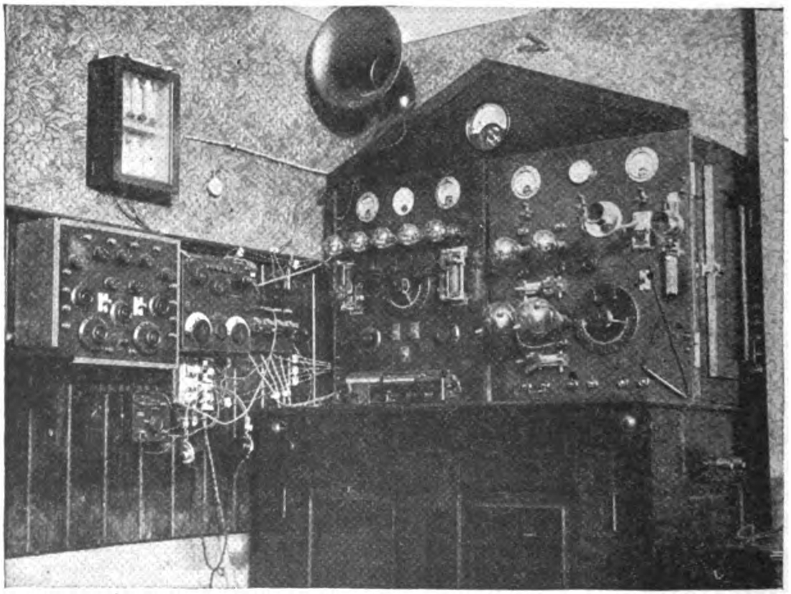
Curiously enough when the war was over the Post Office authorities were reluctant to grant permission to the society to resume its active pre-war operations, and it was not until 1919 that a committee was appointed to formulate a plan so that the station could again be re-opened; this was accordingly done and the desired permission was obtained.

During the war, however, amateur wireless societies sprang up like mushrooms and the Wireless Society of London got busy in the effort to bring them all into one fold.

At the present time there are about one hundred and twenty-five societies affiliated with this parent organization.

The first broadcasting to be done in Great Britain was done by the amateurs themselves. In the London district nearly every evening in the week during the past two years there has been broadcast entertainment of some kind; indeed, so prevalent had amateur broadcasting become in 1921 that the society had to call together all of those who held transmitting licenses in and around London in order to regulate their programs so that the interference of the sending stations would be reduced to a minimum.

In the same year another conference of the society was held. The new president, Dr. J. Erskine-Murray, at that time asked the Postmaster-General to give the Marconi Company —who stood ready and willing to do it—permission to broadcast a weekly program. After some six months elapsed this request was refused. Here, then, was a test for the strength of the affiliated wireless societies. The secretary of the Wireless Society of London sent out a petition to the various societies throughout Great Britain which asked the Postmaster-General to grant permission to the Marconi Company to broadcast a weekly program. This petition was signed by the presidents of



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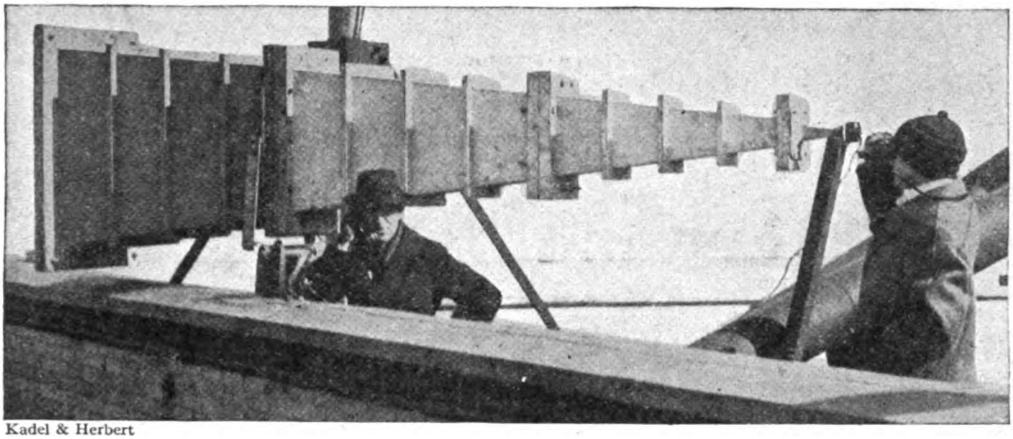
A RADIO SET WITH AN ENGLISH ACCENT

The distinctly foreign appearance of this apparatus is apparent at a glance to the American amateur. Note the receiving equipment (on the left) for reception on high and low wavelengths, and the "thermionic tubes," for transmitting, on the large gabled cabinet at the right. Both receiving and sending stations in England require government licenses, which are issued only to stations that use British-made parts.



Kadel & Herbert

A LOUDSPEAKER THAT WAS HEARD FOR MILES

When the president of a large manufacturing company recently sailed from New York, he was bidden farewell by his employees by means of this gigantic instrument that bellowed messages and songs to him from the roof of the office building. Radio fans who use amplifiers will recognize how the stunt was done.

sixty-three societies. Before a fortnight had elapsed the desired permission was granted.

Within another fortnight the Marconi Company began to broadcast a musical program every Tuesday night. Immediately there was a great demand for wireless receiving apparatus. It was a good rule for it worked both ways in that as the number of users of these sets increased the greater the necessity grew for more broadcasting stations; further, and even more important, the wireless enthusiasts who lived beyond the range of the London broadcasting station wanted cities nearer to them to have similar stations.

Now there are six large British electrical companies who had the financial backing, the engineering brains and the electrical equipment to operate broadcasting stations if they chose to do so. If all of them had entered the field independently chaos would have certainly followed. These six big companies are the Marconi Wireless Telegraph Company, the British Thompson-Houston Company, the Metropolitan-Vickers Electrical Company, the General Electric Company and the Western Electric Company.

To prevent the confusion that necessarily would have resulted had each of these companies operated its own broadcasting station the heads of them decided to organize a company which would be devoted solely to broadcasting; thus it was that the British Broadcasting Company, Ltd., was organized. Of this Lord Garrisford was made the chairman.

This new company has just acquired the license for the erection and operation within Great Britain and Ireland of stations as a public service for broadcasting by means of wireless telegraphy and telephony. News, information, concerts, lectures, speeches, weather reports, theatrical entertainments and other matter of interest will make up the programs which are to be given every evening.

As the British Broadcasting Company operates under the license of the Post Office, the Postmaster-General will only issue the licenses for receiving sets to those who buy their wireless sets of members of the company. That is, every British manufacturer of wireless apparatus must become a member of the Broadcasting Company before he can sell receiving sets of any kind and each set must be approved by the Post Office authorities, which mark it with a seal.

No foreign-made sets of any kind can be used for receiving broadcasting programs and this ruling of the Postmaster-General will remain in force for the next two years. Moreover, no one can get a license for, or use a receiving set until it is marked with the official seal.

Prior to the organization of the Broadcasting Company, which has just been effected, only a British subject could get a license to use a receiving set, but this restriction has now been removed.

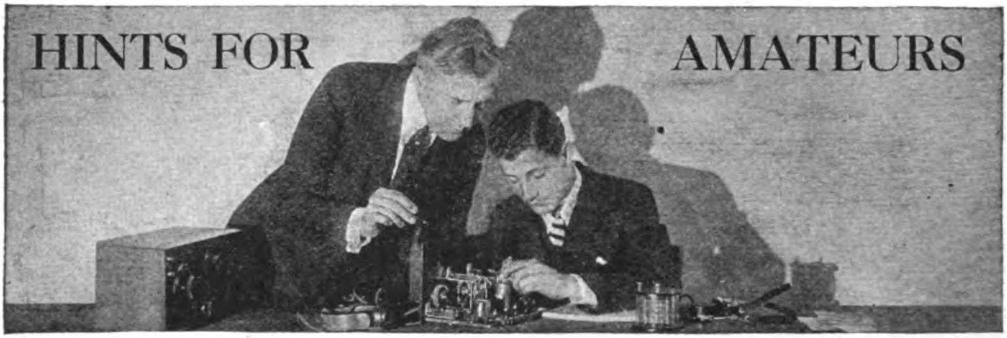
The purpose of having all of the makers of apparatus join the Broadcasting Company is to provide the latter with funds to carry on the broadcasting stations and to standardize all the receiving sets to the end that they will not re-radiate. Further, the Post Office charges the amateur 10 shillings (about $2.25) for a license to receive; half of this sum will be handed over to the Broadcasting Company to help defray expenses.

There are now broadcasting stations located at London, Manchester, Birmingham and Newcastle; others are being fitted up at Plymouth, Cardiff, Glasgow and Aberdeen. Those who own vacuum tube receiving sets can easily get one or all of these stations, but for the benefit of those who own crystal receiving sets other stations are being planned.

British radio enthusiasm is really under way.

A. Frederick Collins

HINTS FOR AMATEURS



When you connect up a set from a diagram, you will find it helpful to observe the following procedure:

Start at the antenna binding post and connect it to the instrument as shown in the diagram you are following. When this connection has been completed, draw over that connection on the diagram with a colored pencil. You will then know that that connection is complete. Then from the other terminal of the same instrument connect a wire to the next instrument as shown on the diagram. Cover this connection on the diagram with a colored pencil line and do the same thing with every line on the diagram.

When all the connections are redrawn in colored pencil you will know that you have completed hooking up your set and that it has been done correctly. This will eliminate mistakes and make the job simple.

* * *

Oscillations are induced in an antenna by passing radio waves only when the antenna circuit is tuned to the frequency of the oscillations which caused the waves to be radiated from the distant transmitting antenna. You have to tune in the signals that you desire to hear by adjusting the knobs that control the capacity or inductance in the antenna circuit of your receiver, before the passing waves will cause currents to flow through your receiving instruments, thus supplying the necessary electrical energy to cause the telephones to function and reproduce the transmitted signals.

Bakelite or formica panels for radio sets, if left with the natural highly polished finish, soon become scratched and ragged. A durable satin finish may be imparted to the panel by rubbing it with sandpaper of medium coarseness—rubbing in one direction until the surface is perfectly smooth and all irregularities have disappeared. A smooth grade of sandpaper should then be used until a dull finish is obtained. This will leave the panel with a gray-green tint, but upon applying some furniture oil to the surface and rubbing dry with a soft cloth, a beautiful black color will appear which will be permanent. Rub the panel in one direction only, with a long straight stroke.

* * *

When you solder connecting wires to the terminals of jacks for making connections to the telephones, it is important to keep soldering flux from running down onto the insulating segments which separate the different spring contacts.

If the flux runs down into the insulating segments it causes leakage and it is to this that many experimenters owe the trouble they have with their homemade sets.

Use only enough flux for the solder to take hold; a thin film is enough.

Another point to remember: be sure that the contacts make and break properly when you have completed the wiring of the set. Sometimes they get bent out of position slightly and do not touch properly; you may never discover it, and never get the new set to work right.

It may interest the novice to know that the ordinary vacuum tube used for receiving is rated at a power of approximately one watt, or about one-fiftieth of the power that is used to light the ordinary electric-light bulb.

* * *

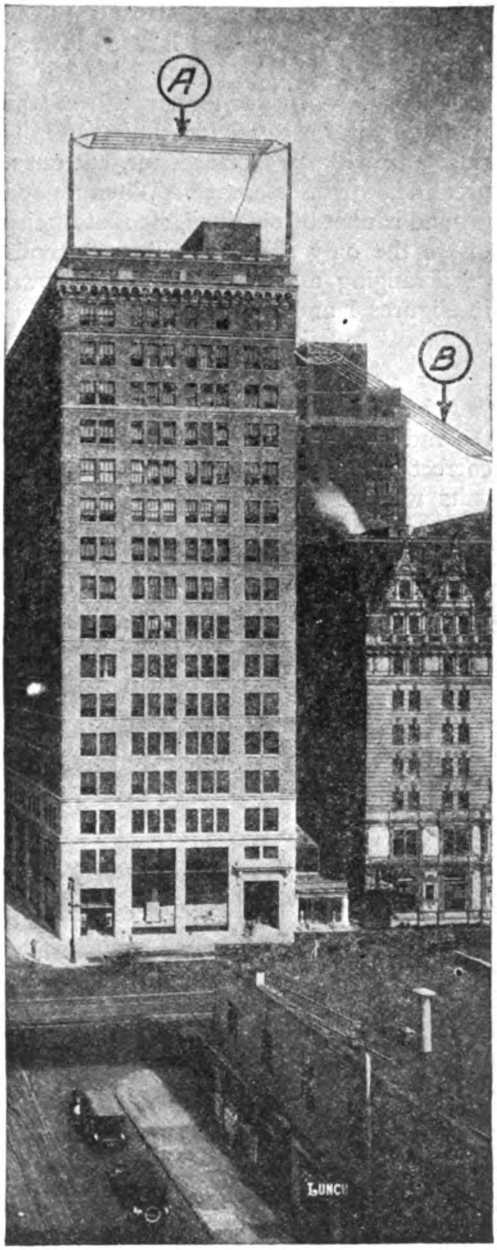
Many amateurs who build their first vacuum tube transmitting set, can get it to oscillate properly only on wavelengths that are in excess of what is allowed them by the law. When they find that it is impossible to make it function properly on a lower wavelength, it is natural for them to get reckless and "take a chance." They adjust it for the lowest wave on which they can radiate and let it go at that. Eventually the radio inspector pays them a visit and their license is suspended.

They could avoid all this trouble if they understood the difficulties involved and knew that a counterpoise would solve them.

When a set refuses to work on a low wavelength, the cause is usually one of the following two points: the antenna resistance is too high, or the antenna capacity is too high. In the first case, the antenna oscillating circuit has such a large value of resistance that it can not be induced to sustain oscillations; they are damped out. In the second case the capacity is too high and the antenna really acts as a short circuit to the vacuum tube oscillator circuits.

A counterpoise will remedy this trouble, as it will reduce both antenna resistance and capacity. At the same time it will be the equivalent of a perfect ground and it will enable you to have almost double the radiating surface that is presented by an ordinary antenna and ground system.

For best results a counterpoise should be stretched underneath the antenna, near the ground, but not touching it; its area should be equal to or more than the area of the antenna itself. Good results, however, may be obtained with a counterpoise consisting of another antenna just



Brown Bros.

HOW A COUNTERPOISE IS INSTALLED IN THE CITY

Figure 1: *When the available space is limited the counterpoise may be practically a second antenna which runs off in another direction from the main antenna; indeed, this is often the only arrangement that is possible in the city where ground space on which to set up a counterpoise in the usual way is conspicuous by its absence. In this picture A is the regular antenna and B is the counterpoise.*

like the main antenna that runs off in some other direction and is used instead of a ground.

A counterpoise will sharpen up the tuning both for receiving and transmitting, and will, on that account, cut out a great deal of interference. When a good ground cannot be obtained, a counterpoise offers the only solution. Two methods of arranging a counterpoise are shown in Figures 1 and 2.

* * *

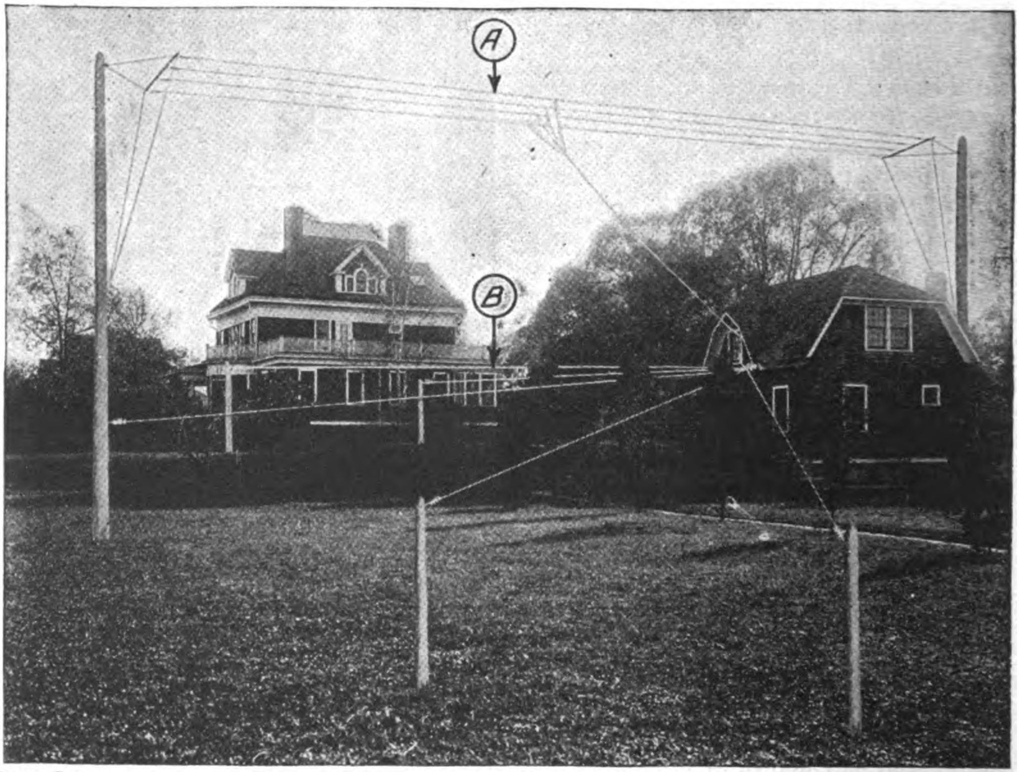
If a potentiometer is used across the "A" battery for maintaining the grid of the radio frequency amplifier tube at the correct free grid potential, the best results will be obtained. If the potentiometer is advanced too far in one direction, however, the tube will begin to oscillate and the telephone signals will disappear. The amplifier can be used for picking up C. W. signals when the tubes are oscillating by slightly detuning the circuits from the wavelength of the transmitting signal; then the signals will sound like a whistle following the dots and dashes of the code.

* * *

A sharp wave means that the transmitting station radiates a large proportion of energy in the form of Hertzian waves of uniform length, and only a small proportion of energy in the form of wavelengths which vary from this.

* * *

Do not "test" any kind of a battery by "shorting" it with a pair of pliers or a wire, as this injures it. The best way is to use a voltmeter across the battery while it is discharging at its normal rate.

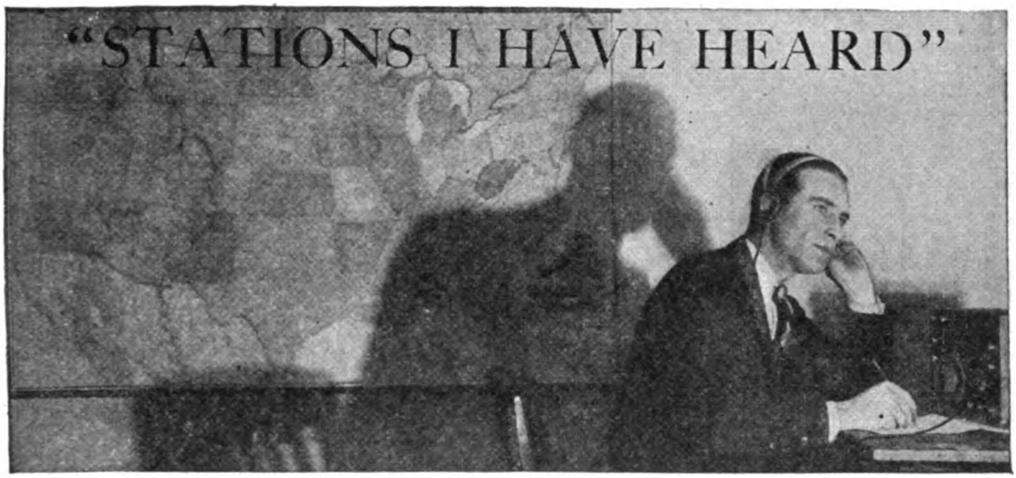


Brown Bros.

A PRACTICAL SUBSTITUTE FOR YOUR GROUND

Figure 2: *To be most effective the counterpoise B should be placed directly under the antenna A; it should be fan-shaped and should be suspended high enough above the ground to be well clear of the head of any passerby.*

"STATIONS I HAVE HEARD"



If *you are getting good results with your receiving set, tell your fellow-readers of* Popular Radio *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* How You Are Using It.

WHAT THREE SPIDER-WEB COILS CAN DO

Using three spider-web coils, Kenneth Ogden of New Haven, Conn., makes his single tube cover a distance of 900 miles. His record reception is from WOC, Davenport, Ia. He also hears WDAJ of College Park, Ga., and 21 others.

The coils are home-made, he says, and are used with a 43-plate condenser in the antenna circuit and a 23-plate condenser across the secondary coil. His antenna is made of two wires, spaced three feet apart, 120 feet long, suspended 35 feet above the ground.

* * *

LIKES REINARTZ HOOK-UP

In case it means anything to anybody, Earl Lampman wants to mention that by using one tube in a Reinartz circuit, he has heard KHJ and KFI of Los Angeles, Calif., approximately 1,850 miles away.

* * *

HE HEARS ACROSS THE ATLANTIC

Another to join the distinguished ranks of plain ordinary laymen who are picking up American concerts in Europe is Joseph P. Price, who writes from Sussex, England, that he hears WEAF of New York with five tubes in a radio frequency hook-up.

* * *

CRYSTAL SET SPANS DISTANCE OF 750 MILES

H. P. Johnson of Victoria, B. C., is surprising himself by receiving broadcast programs 750 miles away on his crystal receiver. His outfit consists of a home-made variocoupler, tapped at every turn for seven turns and then at every tenth turn for seventy more turns, making a total of eighty turns. He uses 2,000-ohm phones and a piece of galena for a detector. His antenna is made of two stranded wires 75 feet long suspended 35 feet above the ground. He writes:

"On the evening of January 27 my son received a program from KPO, San Francisco, Calif., and heard the announcer distinctly. We believed this to be some queer freak of radio until we picked up the same station a number of times later, and under various weather conditions.

"We have also heard talking and singing on this same simple set from Portland, Ore., and from another station in San Francisco which we are as yet unable to identify. The music from KPO came in quite clear and distinct and the whole orchestra was plainly heard as well as piano and violin solos and a number of vocal selections."

* * *

5,000 MILES IN TWO HOURS IN AN ARMCHAIR

"Speaking of records for speed," writes E. R. Hammond of Newark, N. J., "I have just figured the mileage my armchair has made during the past two hours. I have traveled over 5,000 miles, with the aid of my three tubes and my standard hook-up of two variometers and a variocoupler.

"I listened to a popular song being played in about seven kinds of syncopation at once by WWJ in Detroit, Mich, and by a slight movement of the dials which did not even disturb the ashes on my cigar, I heard a lady finish up with the chorus of the same song at WSB, Atlanta, Ga. Others on my calling list were WHB, Kansas City; WIP, Philadelphia, Pa.; WGY, Schenectady, N. Y.; and WDAP, Chicago."

* * *

REACHES 23 STATES WITH THREE TUBES

A total of 58 stations, located in 23 states, were heard by John S. Frampton in Spangler, Pa., during a period of 17 days, he says. He made the DX receiver described in the January number of POPULAR RADIO, using an aerial only 15 feet above the ground.

The greatest distance over which he received is 2,250 miles. The station is KOG of Los Angeles, Calif. Other records are PWX of Havana, Cuba, 1,260 miles; WBAP, Fort Worth, Tex., 1,170 miles; WLAL Tulsa, Okla., 1,000 miles, and five others more than 1,000 miles away. The total distances of all stations heard amounts to 31,994 miles. He has heard as many as 27 stations during one evening.

"Using either the ground connection or the antenna alone, I can hear Chicago and Atlanta, Ga., with fair volume," Hampton says, "and when in Brooklyn, I can pick up WEAF of New York without either."

The aerial, 15 feet high, is made of one strand, No. 16 rubber covered wire, 120 feet long.

* * *

ONE TUBE COVERS 1,000 MILES

WHILE it is not unusual for one tube to cover a distance of 1,000 miles with proper tuning devices and a good antenna, the set which will do it consistently in several different directions is good enough to make listeners in wonder how it is done.

Raymond H. Carlson of Wheeling, W. Va., does it with a single-circuit tuner. He tunes his aerial by using various lengths of wire, and has decided that 50 feet is the best length for his particular type of set, and that added length weakens his signals.

His best records are PWX, Havana, Cuba; KDZU, Denver Colo.; DN4, Denver, Colo.; WDAO, Dallas, Tex., and CJCG, Winnipeg, Canada, all more than 1,000 miles away. He has heard from 22 states.

* * *

GIVES COUNTERPOISE CREDIT FOR LONG-DISTANCE RECEPTION

FOR covering a distance of 1,500 miles with one tube, the counterpoise of M. S. Levert of Boston, Mass., is given chief credit. Before he erected the counterpoise he could not receive as far as 1,000 miles, he says.

His tube works on a storage battery, and his set is tuned with two condensers, a variocoupler and a variometer. The aerial consists of four strands of wire spaced two feet apart, 100 feet long and 45 feet high. The counterpoise, used instead of a ground connection, has similar dimensions and is hung nine feet above the ground.

* * *

A FAN WHO HAS PICKED UP EVERY STATION IN THE COUNTRY

SIGHING with the shade of Alexander, Arthur F. Glover of Kansas City, Mo., regrets that "there are no more worlds to conquer." He hears everything in the United States, and after he has finished with the other continents, there will be nothing new to hear unless it be from the other planets which to all appearances are behind the times.

As he is located in the center of the United States, his greatest records, with his six tubes, are KHJ of Los Angeles, Calif., and WKAQ of San Juan, Porto Rico. He hears 87 others, knows most of the popular songs by heart and says that he is studying Spanish by the ether method.

* * *

HOW HIS SMALL SET GREW

WITH practically no tools at all, Hilliard Hamblin of Warsaw, Canada, made a crystal set, using what he happened to find about the house. It has now grown into a single tube set and in this second venture he has heard 50 stations, the total of their distances amounting to 25,155 miles.

"My aerial is only 25 feet high and 100 feet long," he writes, "made from copper ribbon taken from a Ford magneto. I use a well for my ground."

His set has three home-made honeycomb coils, 50 turns in the primary, 100 turns in the secondary and 100 turns in the tickler. He uses 43-plate primary and secondary condensers, a variable grid condenser but no grid leak.

Using 2,000-ohm phones he sometimes covers a distance of 1,500 miles. Some of the distant stations he has received from are WDAP, Chicago, Ill.; WBZ, Springfield, Mass.; KSD, St. Louis, Mo.; WSB, Atlanta, Ga.; WHAS, Louisville, Ky.; WLW, Cincinnati, O.; WAAM, Newark, N. J.; WOC, Davenport, Ia., and WGF, Des Moines, Ia.

* * *

A 53,217-MILE JOURNEY ON ONE TUBE

ALTHOUGH his tube has no mileage guarantee, G. E. Tallman of Seneca Falls, N. Y., writes that it has gone 53,217 miles and has not begun to show signs of wear. He arrives at the mileage by adding the distances of 85 stations he has heard with his single-circuit regenerative receiver. His aerial is a single solid wire 165 feet long with a 35-foot lead-in.

His record includes KHJ, Los Angeles, Calif.; 2,300 miles; CJCE, Vancouver, B. C., 2,230 miles; PWX, Havana, Cuba, 1,475 miles; WGAB, Houston, Tex., 1,400 miles; WCAJ, University Place, Nebr. and WNAX, Normon, Okla.

* * *

HOW A $14 RECEIVER DOES IT

"MY friends do not understand how I do it," says D. Cromar of Windsor, Canada, who covers more than 800 miles on his crystal set, and goes on to remark that it is a simple matter. He uses a loose coupler, home-made, a 23-plate variable condenser, a phone condenser and a piece of galena. These instruments, together with his phones, cost $14.00.

The aerial used is made of two wires 50 feet long and 30 feet high. The lead-in is 50 feet long, and he uses the water pipe for a ground connection. During a period of seven hours, from seven in the evening until two in the morning, he has heard KDKA, Pittsburg, Pa.; KDQA, Chicago Ill.; WCI, Barnegat, N. J.; WSA, East Hampton, N. Y.; WSB, Atlanta, Ga.; WDAC, Springfield, Ill.; WHAZ, Troy, N. Y.; WIAP, Springfield, Mass.; WCV, Cape May, N. J.; WSV, Little Rock, Ark.

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Ether Waves in an Igloo

WHAT is probably radio's "farthest north" is reported by Mr. J. P. Henderson, of a Dominion Government exploration party; at Fort MacPherson, well within the Arctic Circle, music broadcast by CFCN at Calgary, 2,000 miles away, came in loud enough—when a loudspeaker was used—to fill a large igloo. The Esquimaux held a weird impromptu dance to this music and bestowed on W. W. Grant, the announcer at CFCN, an unpronounceable name that means "the voice from the box."

* * *

The Most Powerful Radio Station Afloat

WHEN the U. S. S. *Leviathan* is put into operation by the United States Shipping Board this June it will not only be the largest vessel to fly the Yankee flag but it will carry the most powerful and the most complete radio outfit ever placed on a ship. In addition to its regular radio telegraph apparatus consisting of a vacuum tube set capable of delivering six times as much power to the antenna as the usual ship outfit and able to maintain communication at a distance of 3,000 miles, it will be equipped with radio telephone and with two emergency sets.

* * *

South Americans Listen in on a New York Fight

NEW YORK was joined to Argentina by radio for the first time in history when round-by-round ringside reports of the Firpo-Brennan prize fight were transmitted from the high-power radio station at Rocky Point, L. I., and were picked up in Argentina. The reports were sent out on a long wavelength; for the benefit of local fans, after they were received they were immediately sent out again on a short wavelength by an Argentine broadcasting station.

* * *

Radio Saves a Life at Sea

JOHN H. STEEL of the U. S. Lighthouse Service owes his life to radio. He was on duty on the Fenwick Island light-ship, thirty miles southeast of Cape May, when he was taken suddenly with an acute attack of appendicitis; immediately a radio call for help was sent out, and a Coast Guard cutter, in spite of a storm that was raging, made its way out to the lightship. He was transferred to the cutter, and rushed ashore in time for an operation that saved his life.

* * *

Radio in the Home of the Buccaneers

ONE of the last parts of the world to remain in primitive isolation will be connected to civilization when a radio station is set up which will enable the Turks and Caicos Isles, chiefly known as the ancient haunts of the pirates, to communicate with the other islands of the West Indies.

International

TALKING THROUGH HIS HAT

With an umbrella for an antenna and a receiving set in a straw hat, Miss Helen Flaishman, of Philadelphia, has devised this stunt set. It was made by her fifteen-year-old brother Nathan.

A Transmitting Machine That Sends 80 Words a Minute

In tests recently conducted between the *Majestic* and a shore station a speed of 80 words a minute was attained by the use of sending and receiving machines, and was shown to be practicable for commercial use. Some idea of what this means may be gained from the fact that it is virtually impossible to maintain a speed higher than 25 words a minute when messages are transmitted and received by hand.

Underwood & Underwood

WHO OWNS THE ETHER?

The first radio lawsuit to involve this question is being tried in Illinois with Herbert Hoover and Hiram Maxim among the distinguished witnesses. Wylie Bergman, the eighteen-year-old owner of a $1,000 transmitting station (the antenna tower of which is shown above) is being sued by Edward McWilliams, a banker, on the ground that he interferes with McWilliams' reception of the broadcasting.

* * *

Lighthouses to Flash Radio Beams

A new phase in the history of radio as a means of insuring a greater safety to ships at sea will open with the installation on all lightships and lighthouses during the next three months of radio "beacons" for the purpose of sending directional signals which will enable mariners to establish their exact location. These "beacons" will be of enormous value in foggy weather when a lighthouse is virtually out of commission; even in clear weather they will carry farther than the ordinary light.

* * *

Another High Award in Science Goes to an Inventor of Radio Apparatus

The Franklin Institute of Philadelphia has awarded the Elliott Cresson Medal to Dr. Lee De Forest for his invention of the audion or three electrode vacuum tube. The committee report on which the award was based characterized the invention of the audion tube as "one of the most important ever made in the field of the electrical transmission of intelligence."

* * *

French Fans Are Beginning to Listen In

There are now about 50,000 privately-owned radio receiving sets in France—as compared to an estimated 2,000,000 in the United States.

* * *

Radio Fans to Have a Church of Their Own

To bring the church direct to the people by radio is the plan proposed by the Radio Church of America, which was incorporated recently in Sacramento, California, under the laws of the State of California. It purports to be non-sectarian and non-denominational. Headquarters of the church will be in San Francisco. Branches will be established wherever a broadcasting station is available.

* * *

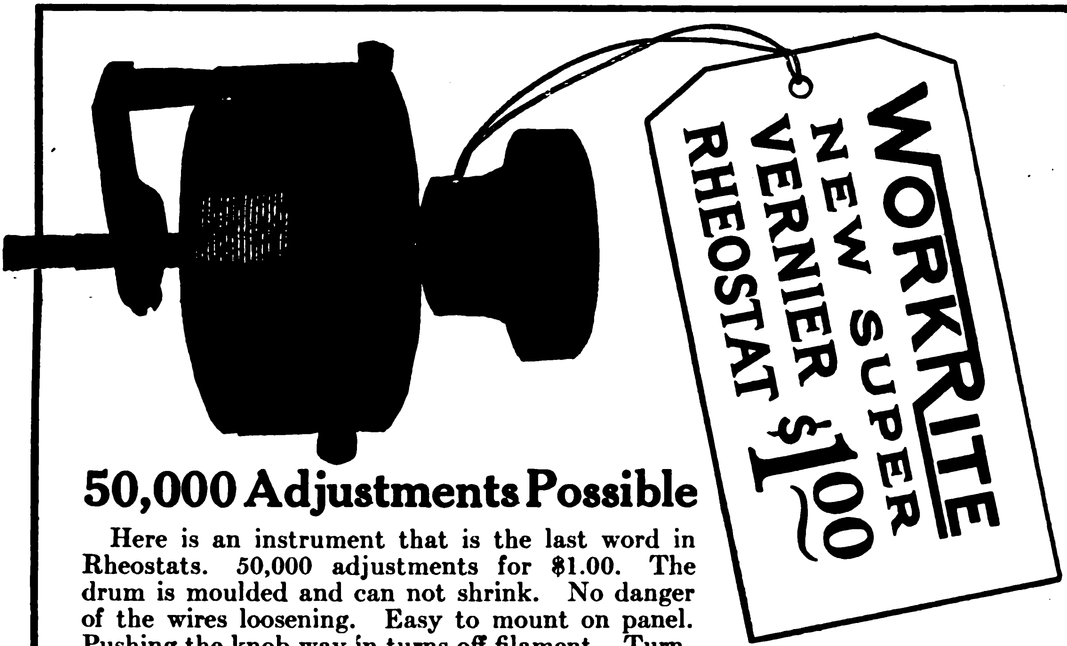
6,000 New Fans a Month in England

In spite of the relative difficulty in amateur operation owing to a government control that requires a license for every receiving station and prohibits the use of home-made apparatus, the wave of radio enthusiasm that has just begun to hit England seems likely to become at least comparable to what it was here. One month's application for licenses was 6,000—and that was before the "boom" had really started.

* * *

Do Insects Communicate by Radio?

Dr. E. Porter Felt, the state entomologist of New York, points out that there is a marked resemblance between the antennas of insects and the solenoid or loop antenna used with radio. He has received successfully using an antenna patterned carefully after that of the gall midge. While it is probable that these antennas are designed for the reception of sounds too minute to be audible to the human ear, it is within the bounds of possibility that insects actually do communicate by radio.



50,000 Adjustments Possible

Here is an instrument that is the last word in Rheostats. 50,000 adjustments for $1.00. The drum is moulded and can not shrink. No danger of the wires loosening. Easy to mount on panel. Pushing the knob way in turns off filament. Turning the knob gives the very finest adjustment. Often a turn of 1/32 inch will clear up a station or separate two stations.

The regular Rheostat has 6 ohms resistance. For the 201A and 301A tubes 6 to 12 ohms resistance is necessary for the best results. For the new UV199 tubes, you need 30 ohms.

A WorkRite Super Vernier Rheostat on your Detector Tube will double the efficiency of your set. Try it and see. Put a WorkRite Rheostat on each of your tubes and get perfect adjustments.

WorkRite New Super Vernier Rheostat $1.00

(With 15 ohms resistance $1.10 With 30 ohms resistance $1.25)

LET US HELP YOU BUILD YOUR RADIO SET

Read What One WorkRite Radio Fan Writes

Dayton, Ohio, March 30, 1923.

Last August I assembled a radio set using your WorkRite Parts, employing your hook-up. With this outfit I have heard voices from every State in the Union with the exception of Nevada and Mississippi, from each border province in Canada, from Cuba, from Porto Rico, and upon three occasions from Hawaii. Pacific Coast stations come in nightly: I have heard 31 of them, etc.

Ralph C. McSherry, 114 N. Western Ave.

OTHER WORKRITE RADIO PRODUCTS

WorkRite Super Variometer	$ 3.50	WorkRite 180° Super Vario Coupler	$3.50
WorkRite E-Z-Tune Dial	.75	WorkRite Concert Headset	6.00
WorkRite Concertola, Jr.	12.00	WorkRite Switch Set	.50
WorkRite Concertola, Sr.	24.00	WorkRite Hydrometers	.75

WorkRite 25 ohm Resistance Cartridge 40 cents

"WorkRite Radio Parts WorkRite"

THE WORKRITE MANUFACTURING CO.

5512 EUCLID AVE., CLEVELAND, OHIO

(Branch Office, 536 Lake Shore Drive, Chicago)

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

J812—43 plate .001 Mfd. $1.73
J813—21 plate .0005 Mfd. 1.43
J814—11 plate .00025 Mfd 1.32
J815—3 plate Vernier 98c

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

J824—23 plate .0005 Mfd. Price $2.89
J826—43 plate .001 Mfd. Price 3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

INDUCTANCE "HONEY COMB" COILS

Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Meters	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	J301	$0.39	J320	$0.89
35	175- 450	J302	.42	J322	.96
50	240- 720	J303	.49	J323	1.04
75	390- 910	J304	.54	J324	1.08
100	500- 1450	J305	.58	J325	1.13
150	600- 2000	J306	.63	J326	1.17
200	900- 2500	J307	.72	J327	1.26
250	1200- 3500	J308	.78	J328	1.35
300	1500- 4500	J309	.82	J329	1.36
400	2000- 5000	J310	.97	J330	1.57
500	2800- 6100	J311	1.12	J331	1.63
600	4000-10000	J312	1.27	J332	1.78
750	5000-12000	J313	1.43	J333	1.93
1000	7900-15000	J314	1.70	J334	2.28
1250	9750-19500	J315	1.92	J335	2.49
1500	14500-26500	J316	2.18	J336	2.65

COIL MOUNTINGS

J340—Three coil mounting...... $3.95
J341—Two coil mounting...... 2.95

High grade fine looking mounting. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. J732—Each 59c

This Guarantee Protects You. **Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.**

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

J105—Detector UV200 or C300 .... $4.38
J112—Amplifier UV201A or C301A. Each........ $5.95
J115—5 Watt Transmitter......... 7.70
J107—WD11 1½ volt............. 5.95
J109—WD11 adapter. Each...... 48c

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.

J140—For Standard Base Tubes. Each.......................... 39c
J108—For WD11 Tubes. Each.... 49c

PORCELAIN BASE AND TUBE

J144—Crosley for either panel or table mounting for Standard Base.. 36c

High Grade combination type for panel or table mounting Metal tube. Highly insulated base. For Standard Base Tubes.
J146—Each 45c

GRID CONDENSER

J162—Mounting holes spaced to fit lugs of above leak Cap. .00025 MFD.......... 14c
J163—Same as 162 but higher grade. Enclosed in metal case..... 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
J100—Each....... 19c

VARIOMETER

J410—Completely assembled, price $2.69 Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.

J411—Not assembled but all parts complete, except wire, including winding form $1.48

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

J415—Price, completely assembled.. $2.45
J416—Not assembled, but all parts complete. Price, except wire.... 1.18
J417—Rotor ball only. Each...... 29c
J408—Bakelite Stator tube only. Ea. 35c

RADIO FREQUENCY AMPLIFYING TRANSFORMER

J995—Each....... $3.95

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

J234—10 to 1 Mounted. Each....$3.48
J235—10 to 1 Unmounted. Each.. 2.95
J236— 3 to 1 Mounted. Each..... 3.40
J237— 3 to 1 Unmounted. Each.. 2.85

FILAMENT CONTROL RHEOSTATS

Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
J130—Each........... 45c

Best grade. High heat resisting base. Diam. 2¼ in. cap. 1½ amp. Resistance 6 ohms. 1¼ in. Knob with pointer.
J132—Each........... 45c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
J133—Each.......................... 90c

VERNIER RHEOSTAT

Gives exceedingly fine control of a battery current. A necessity for best receiving results.
J135—Each....... 78c

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

J180—Signal Corps type, small size, 15 cells. 22½ volts. Each.......... 95c

J184—Variable Large Navy size, 5 taps. giving range from 16½ to 22½ volts in 1½ volt steps. Each............$1.80

J188—Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Ea. $3.55

DETECTOR CRYSTALS CAREFULLY TESTED

J736 Galena, Arlington tested, per piece 19c
J738 Silicon, Arlington tested, per piece 19c
J735 Tested, Galena, per piece...... 9c
J737 Tested, Silicon, per piece....... 9c

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
J240—100 ft. coil **49c**
J242—500 ft. coil **$2.35**

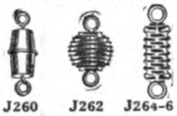
Solid Bare Copper Wire, size 12
J244—100 ft. coil **67c**
J245—500 ft. coil **$3.05**

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

J248—100 ft. coil **72c**
J249—500 ft. coil **$3.20**

ANTENNA INSULATORS

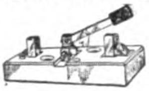


J260—Size 1x3¼. Two for..... **17c**
J262—Size 2⅛x3¼ Two for..... **55c**
J264—Size 1½x4. Two for..... **69c**
J266—Size 1½x 10½. Two for **$1.29**

OUTDOOR LIGHTNING ARRESTER

J980—Price.......**$1.58**
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. **Durable.** The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

J385 Single Pole Single Throw. Each **20c**
J383 Single Pole Double Throw. Each **32c**
J384 Double Pole Double Throw. Each **50c**

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

J380—1″ Radius
J381—1¼″ Radius
J382—1½″ Radius
Each **19c**

SWITCH LEVER STOP

Brass, polished nickel finish.
J386—**Dozen 18c. Hundred $1.05.**

ONE-PIECE DIAL AND KNOB

Moulded of highly polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

J900—2¼″ Diam. for 3-16″ shaft. Ea..**19c**
J901—2¼″ Diam. for ¼″ shaft. Ea..**19c**
J904—3″ Diam. for 3-16″ shaft. Ea...**25c**
J905—3″ Diam. for ¼″ shaft. Ea....**25c**
J906—3½″ Diam. for 3-16″ shaft. Ea.**35c**
J907—3½″ Diam. for ¼″ shaft. Ea...**35c**

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only
J390—Open circuit. Each...**43c**
J391—Closed circuit. Each..**49c**
J392—Two circuit. Each...**60c**
J393—Single-cir. fila. control..**69c**
J394—Two cir. fila. control...**85c**

J395—**Plug.** Large space with set screws for attaching cord. Each...........**49c**

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts.

J387—Open Circuit Jack. Each...**27c**
J388—Two Circuit Jack. Each.....**35c**
J389—Standard Plug. Each........**35c**

BINDING POSTS

J370-2

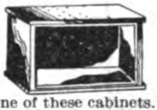
J376-8

Brass, polished nickel finish. Washer and 6-32″ screw extending ⅝″.
J370—Large size—barrel and knob ¾″ long. dozen..............**85c**
J372—Smaller size—barrel and knob 9-16″ long. dozen..............**70c**
J374—Large size with composition knob. dozen..............................**50c**
J376—Large size with hole for phone tip or wire, dozen.....................**80c**
J378—Small size with hole for phone tip or wire, dozen.....................**35c**

STORAGE BATTERY

A very high grade battery made especially for radio Service. Guaranteed. Properly cared for will give years of service for filament lighting.
J194 6-v., 40 amp. size. Each..**$10.00**
J196—**6-v., 80 amp.** size. Each.. **12.50**
Price does not include transportation.

CABINETS



Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7″	5½″	6½″	7″	**J420**	**$2.48**
6x10½″	5½″	10″	7″	**J422**	**2.75**
6x14″	5½″	13½″	7″	**J424**	**3.30**
7x14″	6½″	13½″	7″	**J423**	**3.60**
7x18″	6½″	17½″	7″	**J426**	**3.90**
7x21″	5½″	20½″	7″	**J425**	**4.20**
9x14″	8½″	13½″	10″	**J428**	**3.70**
12x14″	11½″	13½″	10″	**J430**	**4.40**
12x21″	11½″	20½″	10″	**J432**	**5.25**

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel	⅛″ thick		3-16″ thick		¼″ thick	
Size Inches	Art. No.	Price	Art. No.	Price	Art. No.	Price
6x 7	**J450**	**$0.50**	**J460**	**$0.75**	**J470**	**$0.98**
6x10½	**J451**	**.75**	**J461**	**1.18**	**J471**	**1.47**
6x14	**J452**	**1.05**	**J462**	**1.55**	**J472**	**2.05**
7x14	**J458**	**1.20**	**J468**	**2.60**	**J478**	**2.40**
7x18	**J453**	**1.55**	**J463**	**2.30**	**J473**	**3.10**
7x21	**J457**	**1.78**	**J467**	**2.65**	**J477**	**3.60**
9x14	**J454**	**1.60**	**J464**	**2.30**	**J474**	**3.10**
12x14	**J455**	**2.10**	**J465**	**3.10**	**J475**	**4.15**
12x21	**J456**	**3.15**	**J466**	**4.65**	**J476**	**6.20**

HOME CHARGER BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. **Prices are Transportation Paid.**
J201—For 6 volt battery..........**$13.95**

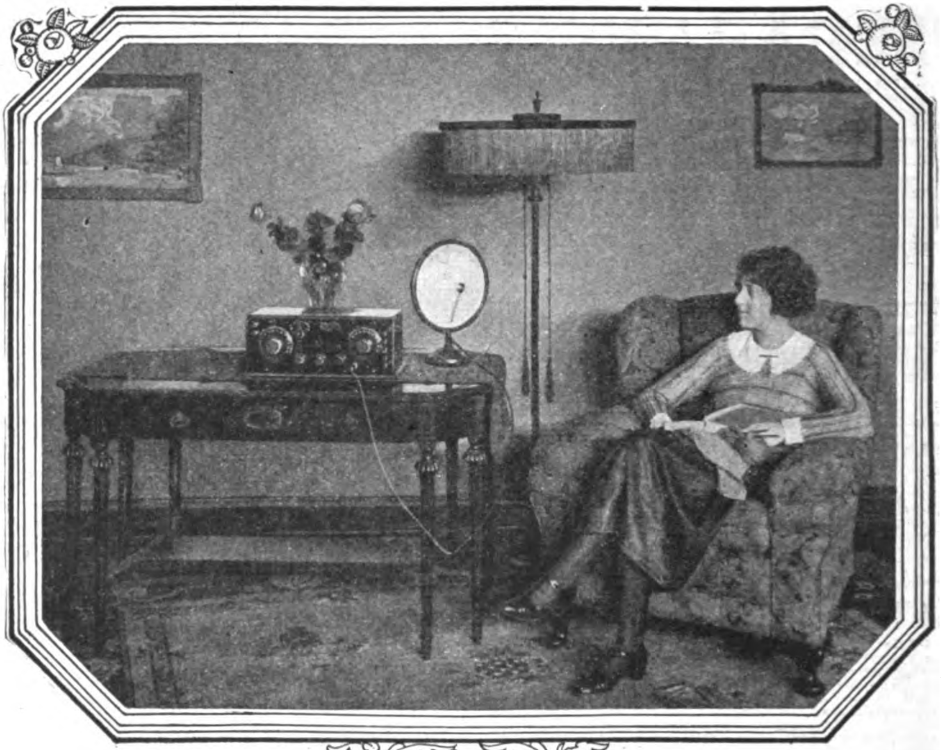
BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.
J770—2000 ohm...............................**$3.75**

OTHER STANDARD BRAND HEADSETS

J751—Murdock 56, 2000 ohm......**$4.20**
J752—Murdock 56, 3000 ohm...... **4.95**
J764—Frost, 2000 ohm............ **4.20**
J766—Frost, 3000 ohm............ **4.85**
J756—Red Head, 3000 ohm......... **5.85**
J758—Western Electric, 2200 ohm..**$9.50**
J754—Baldwin Type C with universal jack plug..................**12.00**
J755—Baldwin Type C unit....... **5.50**
J768—Brandes, 2000 ohm......... **6.95**

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.



The SP2 Receiver Has "That Something"—

A Receiver that can be demonstrated with a world of satisfaction and sold with remarkable ease.

The SP2 is everything the radio-receiver purchaser anticipates in the ideal set of his fancy.

It brings in the local stations in all the fullness and clearness of the actual performance of the sender. Stations, broadcasting simultaneously, are tuned in and cut out at pleasure, readily and surely.

Noise and disturbance are practically eliminated. The SP2 is listened to with genuine delight. It gives a QUALITY performance; the entertainment as afforded by broadcasting stations EVERYWHERE—and **at its** best.

Long distance stations come in on the SP2 **clearly** and **distinctly** even to the "faintest" signals that mark the range of a highly efficient receiving set.

The SP2 Receiver has an unlimited range and is nationally known for its compactness of size, elegance of appearance, superiority of quality and scientific perfection.

Retails at $100

CATALOG 101A—A complete catalog of radio equipment and valuable radio information, will be mailed on receipt of 10c in stamps

Distributors For

The SP2 Receiver—
Pathe Loud Speaker—
Amrad—
Cunningham—
Atwater Kent—
Sleeper—
Reflex Speaker—
Callophone—
Homcharger—
Autostat—
Radiall—
Frost—
Baldwin—
Pacent—
Jansen—
Dubilier—
E. M. P.—
A. B. C.—
Keystone—
Hafner—
and other reputable manufacturers.

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Avenue **Pittsburgh, Pa.**

WASTED EFFORT

The building of a radio set is absorbingly interesting.

The prime motive actuating men and boys of all ages in assembling their own receivers is the realization that only by so doing can a practical knowledge of radio telephony be acquired.

Thus, the different circuits and functions of the various parts are better understood.

Heretofore, much tedious labor has been involved in the undertaking. Laying out the panel and the drilling of from forty to eighty holes, as well as the mounting of tap-switches and soldering of primary leads, have all contributed to making the job a laborious one.

Eisemann units and panels eliminate more than half the labor ordinarily required.

All units are simply attached to aluminum panels with screws and nuts. All panels are completely drilled. Several sizes of panels are offered, with openings provided for any number of units that may be desired. The panel, itself, acts as a perfect body capacity shield. The variocoupler is complete—a tap-switch being carried inside the rotor.

Before starting to build a Receiving Set, it will be found worth while to examine Eisemann radio products.

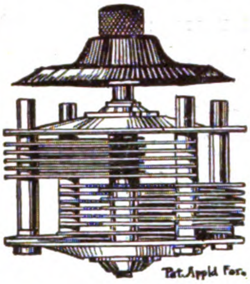
Descriptive literature on request.

EISEMANN MAGNETO CORPORATION
William N. Shaw, ***President***
BROOKLYN, N. Y.

DETROIT CHICAGO **SAN FRANCISCO**

THE STANDARD OF CONDENSER VALUE

HAS BEEN SET BY



Vernitrol Condensers

BALANCED VERNIER TYPE

Supplied in the Following Sizes:

Independent Vernier Plate. Rigid Metal End Shields. Micrometer Spacing. Internally Balanced. Heavy Bearings. Low Losses.

(4-Inch Dial)

.00025 MF.	$5.50
.0005 MF.	6.50
.001 MF.	7.50

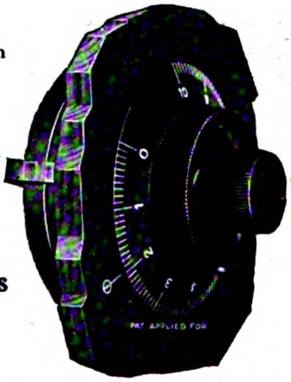
RHEOSTATS AND POTENTIOMETERS

Of Rugged Construction yet giving that Smooth Control so necessary for Fine Adjustment

Duotrol
(Vernier Type with Dial)
$2.00

Amplifier
(Plain Type with Dial)
$1.50

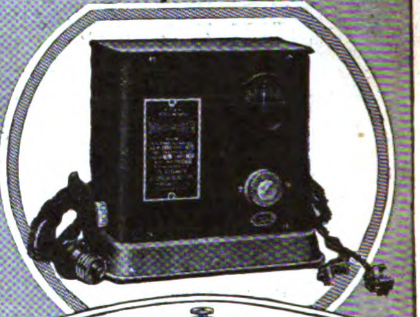
Potentiometers
(300 Ohms with Dial)
$2.50



Complete with dials to repeat settings. Rheostats furnished in the proper resistances for both old and new tubes. Type A-12 ohms. Type A99-30 ohms.

MALONE-LEMMON LABORATORIES
342 Madison Avenue
New York City

CHARGE YOUR RADIO BATTERY at HOME for a NICKEL



PATENTED ARMATURE
The HOMCHARGER'S only moving and wearing part, replaceable after thousands of hours' use for $1.00. Tungsten contacts now used exclusively. Will not stick, corrode or wear excessively.

Enjoyable concerts and maximum receiving range are obtained only when your battery is fully charged.

THE HOMCHARGER

charges your "A" or "B" battery OVER NIGHT for a nickel without removing it from your living room. Operates silently—charging rate governed automatically. No muss—no trouble—no dirt—requires no watching.

The HOMCHARGER is the ONLY battery charger combining all of these necessary features. SELF-POLARIZING—FIVE to EIGHT-AMPERE charging rate—UNDERWRITERS' APPROVAL—beautifully finished in mahogany and old gold—UNQUALIFIEDLY GUARANTEED. Over 100,000 now in use.

The minute you buy a radio set you need a Homcharger—get it then. All good radio and electrical dealers sell it complete with ammeter, etc., for $18.50. $25.00 in Canada.

Write for FREE circular showing why the HOMCHARGER is the BEST battery charger at any price.

MOTORISTS — THE HOMCHARGER will also charge your AUTO Battery.

THE AUTOMATIC ELECTRICAL DEVICES CO.
132 WEST THIRD ST.
CINCINNATI, OHIO

Largest Manufacturers of Vibrating Rectifiers in the World

truth about filament controls

Electronic flow in the vacuum tube depends upon the heat of the filament. This heat varies as the square of the current. Therefore, it is easily seen that the most infinitesimal variation of filament heat has a tremendous effect on the electronic flow and upon reception. A wire wound rheostat cannot provide the fine adjustments necessary to filament control. It was not designed to do so. Inferior filament controls are scarcely better. The Fil-Ko-Stat is distinctly designed to utilize the great tuning possibilities of the vacuum tube. It gives absolute control of the electronic flow, permits the finest tuning possible and assures longer life to the tube. Fine adjustment of fractional currents makes it ideal for dry cell tubes and infinitesimal control of the electronic flow gives that fine adjustment so very essential in D. X. tuning. It is non-microphonic, operates absolutely silent. Fine adjustment starts where tube begins to function. At full on, resistance is practically zero—definite off indicates complete A Battery disconnection.

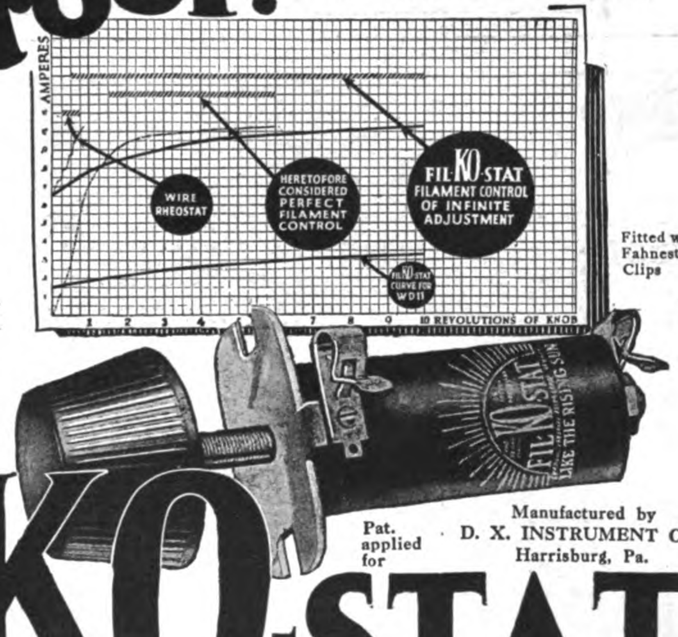
Proof!

Graphic proof of Fil-Ko-Stat superiority as shown here, can be had in any well equipped laboratory. This comparison of fine adjustment control range of Fil-Ko-Stat with rheostat and other filament controls clearly indicates Fil-Ko-Stat superiority.

FIL-KO-STAT
CURRENT INCREASE PERFECT AND GRADUAL
LIKE THE RISING SUN

NO DISCS TO BREAK OR CHIP

Resistance element so finely divided, further division impossible. Fil-Ko-Stat, compact in size, takes little space on panel, replaces other controls without re-drilling.



Fitted with Fahnestock Clips

GUARANTEED

The Fil-Ko-Stat is to all purposes "fool proof." Each instrument is packed with the maker's guarantee that it will be replaced if broken within one year.

$2

Pat. applied for

Manufactured by
D. X. INSTRUMENT CO.
Harrisburg, Pa.

FIL-KO-STAT

Wire orders filled to jobbers and dealers.

Say "Fil-Ko-Stat" to your dealer today. If he has none in stock send his name with your remittance direct to

RADIO STORES CORPORATION

Sole International Distributors. **Department P.R.6, 218-222 W. 34th St.**

PACIFIC COAST BRANCH
329 Union League Bldg.
Los Angeles

The Superlative Inductance

Four years of careful attention to the details of manufacture of this type of inductance unit has yielded a product of unquestioned superiority. And with increased efficiency in manufacturing methods, moderate prices prevail for all sizes

Ask Your Dealer

Cotoco

"Built First to Last"

COTO-COIL CO. PROVIDENCE

WHY METRO HEADPHONES ARE SUPERIOR

TRADE MARK METRO

ACTUATING COILS

METRO HEADPHONES are supremely sensitive, matched in tone and uniformly efficient, largely because of the precise winding of the actuating coils which energize the magnets. Each coil wound with one unbroken length of thin-as-hair wire. Specially designed, extremely accurate winding machine insures uniform tension of wire, entirely eliminating the possibility of short-circuited turns. Only highest grade of pure, enameled copper wire used.

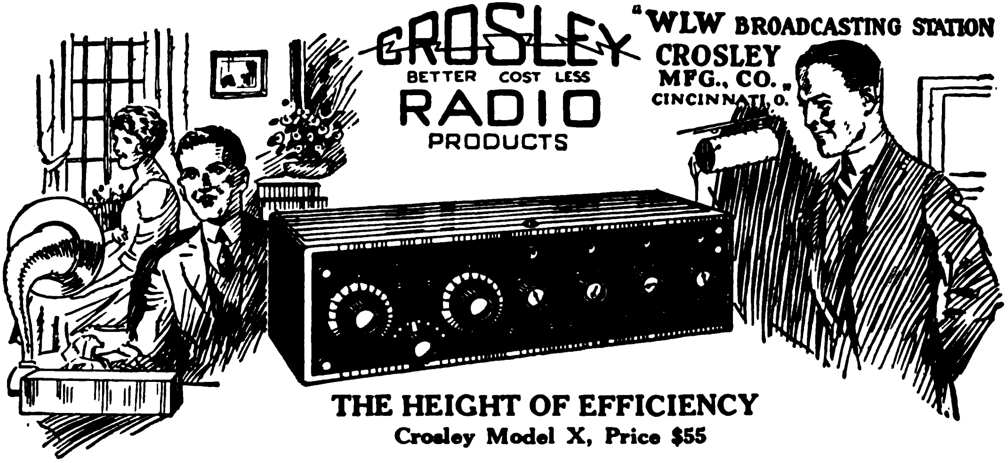
Insist on Metro Headphones and be sure of quality.

$6.00

Little Giant Receiving Set
A surprisingly compact set. Simplest tuning device. Complete with Metro Headphones $14.00

Metro Wave Selector
Makes any set highly selective. Completely separates 360 from 400 meters......... $7.50

METRO ELECTRICAL CO., Inc.
Manufacturers of Metropolitan Radio Products
69 Goble Street Newark, New Jersey



THE HEIGHT OF EFFICIENCY

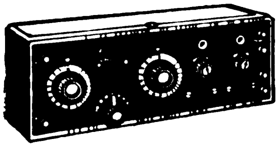
Crosley Model X, Price $55

Clearly, distinctly, as though given in the same room, messages from W.L.W. Broadcasting Station, Crosley Mfg. Co., Cincinnati, are heard in all parts of America if a Crosley Model X—a four tube radio frequency set—is used. This remarkable instrument, very easy to tune, simple and beautiful in construction, has repeatedly brought in messages over 4,900 miles away.

Other Crosley Models, like the Model VIII, three tube set—price $48, and the Model VI, two tube set—price $28, have given exceptional results to thousands of satisfied users everywhere.

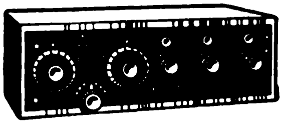
Write for Catalog Showing Complete Crosley Line. For Sale By Best Dealers Everywhere.

Besides a complete assortment of receivers, Crosley manufactures parts for replacement or home construction.



Jobbers and Dealers Will Be Interested in the Crosley Proposition.

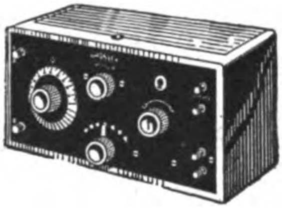
New York Office, C. B. Cooper, 1803 Tribune Bldg., 154 Nassau St.
Boston Office, B. H. Smith, 929 Blue Hill Ave., Dorchester
Chicago Office, 1311 Steger Bldg., 28 E. Jackson Blvd., R. A. Stemm, Mgr.



CROSLEY MANUFACTURING COMPANY

616 ALFRED ST. **CINCINNATI, OHIO**

Remarkable Regenerative Receivers



Ace Model V

$20

Formerly known as Crosley Model Vc

This one tube receiver is astounding the radio world with its wonderful achievements. Stations more than 1,000 miles away are being regularly copied on this set. In comparison to its price, there is no receiver on the market today to equal it in performance.

Because of its size and price the Ace Model V is a great summer seller.

Licensed under Armstrong U. S. Patent No. 1,113,149.

Live Jobbers and Dealers are eagerly taking advantage of the sales this instrument and the rest of the Precision instruments and parts bring them.

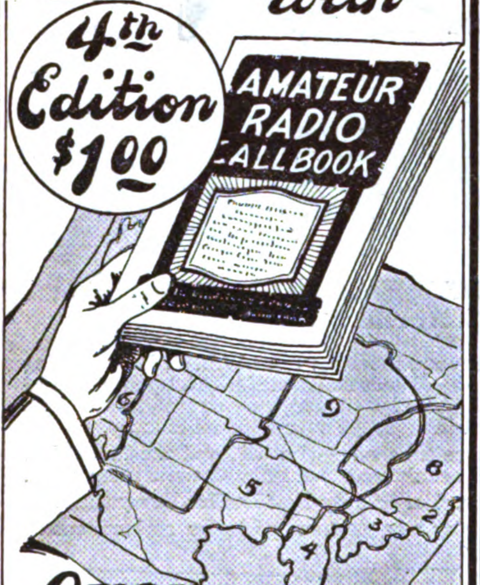
Free Catalog on Request.

THE PRECISION EQUIPMENT CO.

Powel Crosley Jr. President

616 GILBERT AVE. **CINCINNATI, OHIO**

Large Map 2 colors-2X3FT. with



Over 20,000 Call Letters

Indispensable to every radio owner. Contains up-to-date list of over 20,000 Amateur, Commercial, Army, Navy, Transoceanic High Powered, and Broadcasting Stations in the United States and Canada; International Morse Code and Convention Signals; the construction and operation of the **Reinartz Tuner, Detector, and one-stage Amplifier;** also an abundance of other useful information.

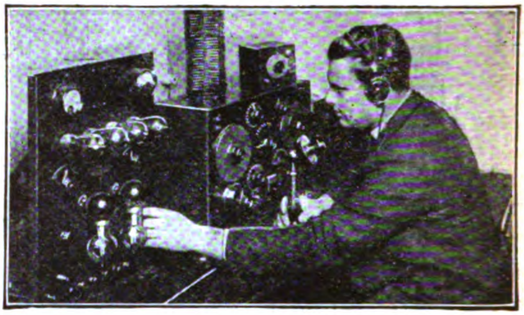
Included with the book is a splendid two-color map of the United States and Canada, 2x3 ft., showing radio district boundaries, standard time lines, geographical location of broadcasting stations, etc.

Buy the Book with the Blue Cover

The greatest dollar value on the radio market. At your dealers or direct by mail. Use check or money order. Do not send stamps.

[*Dealers: write for proposition*

Radio Directory and Publishing Co.
45-J Vesey Street New York City



More Money For You in RADIO

THE amazing expansion of Radio has opened up thousands of wonderful new positions on land and sea. Big salaries, fascinating, easy work, short hours, and a wonderful future are offered to ambitious men who get into Radio now.

Take advantage of these wonderful opportunities to step into a big paying position in this great new field. Radio offers you an opportunity to travel and see the world, with all expenses paid, and a fine salary besides. Or you can stay at home and work up to a position paying up to $10,000 a year.

Easy to Learn Radio at Home

Hundreds of men are already earning handsome incomes in this wonder science. If you want to get into a profession where opportunities are unlimited make Radio your career—become a Certified Radio-trician.

Thousands of Certified Radio-tricians are wanted to design Radio sets; to make new Radio improvements; to manufacture Radio equipment and to install it; to maintain and operate great Broadcasting stations and home Radio sets; to repair and sell Radio apparatus; to go into business for themselves; to operate aboard ship and at land stations.

You can easily and quickly qualify in your spare time at home through the help of the National Radio Institute. Prominent Radio experts will help you. Four wonderful instruments are loaned to students making the work thoroughly practical. The same plan that has already helped hundreds of our graduates to real success and real money in Radio is open to you.

Send for Big Book

No other field today offers such great opportunities as Radio. Take your choice of the many wonderful openings everywhere. Prepare now to step into the most interesting and best paid profession today. Read about the opportunities open now—the different kinds of work—the salaries paid. Write today for the 44 page book that tells how America's first and biggest Radio school can make you a Certified Radio-trician in your spare time. Mail the coupon or write a letter NOW. National Radio Institute Dept., 32-F, 1345 Pennsylvania, Ave., N. W., Washington, D. C.

NOTE: These opportunities are open only to men and boys eighteen and over. High School boys and others under Eighteen years of age interested in radio can make big money in spare time after school hours through our special spare time course. If you want information simply sign the coupon and send it to us.

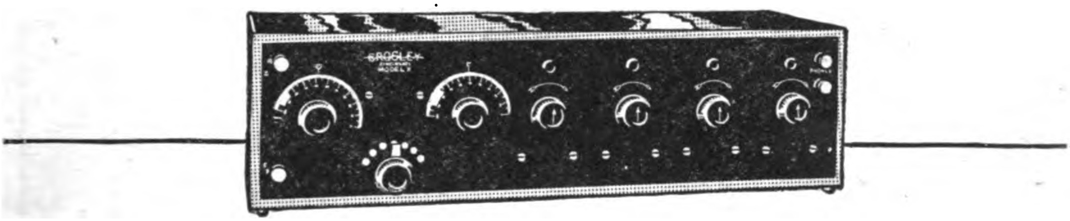
National Radio Institute, Dept. 32-F
1345 Pennsylvania Ave., N. W., Washington, D. C.

Without obligation send me your book "How to Learn Radio at Home" which tells all about the opportunities in Radio, how spare time study at home will qualify me quickly as a Certified Radio-trician so I can get one of the splendid positions, and how your Employment Service helps me to secure the job I want.

Name.................................Age...........

Street...

City.........................State...............



CROSLEY

Uses Formica for Panels and Insulation

CROSLEY radio sets are universally known and used. They are produced in a factory that is famous for its well developed production methods and factory systems.

Radio engineers for the Crosley Manufacturing Company, like those of nearly every other well known independent radio manufacturer, appreciate the superior qualities of Formica insulation for radio.

They use it in panels and for many other purposes in connection with their radio product, because it is good looking, because it works well with ordinary tools and because it has high di-electric strength and maintains it indefinitely, improving with age.

The Crosley Company is a large distributor of Formica panels and of radio parts of its manufacture in which Formica is used for insulation purposes.

Formica dealers can supply you promptly with panels in all standard sizes.
They can also supply special sizes when you want them.

The Formica Insulation Company

4641 Spring Grove Avenue
Cincinnati, Ohio

SALES OFFICES

50 Church St., New York, N. Y.
422 First Ave., Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Bldg., Toledo, Ohio

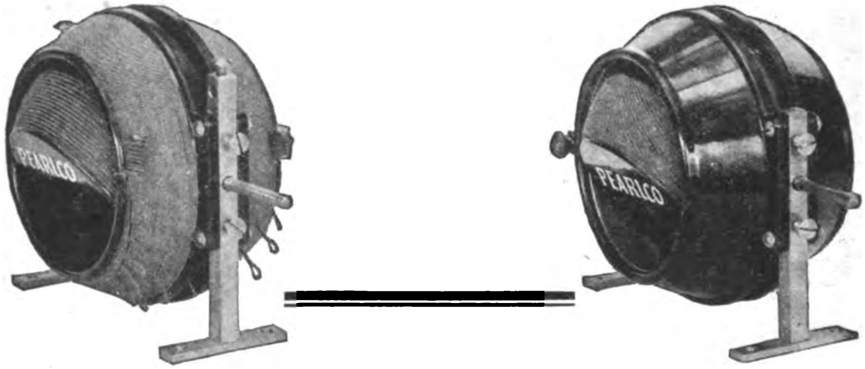
1210 Arch St., Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Bldg., San Francisco, Cal.
Whitney Central Bldg., New Orleans, La.

414 Finance Bldg., Cleveland, Ohio
9 S. Clinton St., Chicago, Ill.
313 Title Bldg., Baltimore, Md.
47 King St., Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

RADIO

PEARLCO PRODUCTS



PEARLCO RADIO PRODUCTS, of which the variocoupler and variometer, molded in Bake-Lite, here shown are specimens, are now being successfully introduced to Radio Owners.

Made under the supervision of a noted radio engineer of 18 years' experience, these products are guaranteed the best of their kind on the market.

Please ask any dealer about Pearlco Products or write us.

PEARL RADIO CORPORATION
1033-35 Race Street Philadelphia, Pa.

BOTH HEAR ALIKE

CLARION

"Uniform Quality" Headsets

$5.00

Thousands of Satisfied Users Know—

Clarion "Uniform Quality" Headsets are built from the best of materials and with careful attention to the fine manufacturing details necessary for the production of delicate and uniform receiving apparatus.

Clarion "Uniform Quality" Headsets do not add a tone of their own to the broadcast, varying with each headset, but reproduce voice and music as transmitted.

Clarion "Uniform Quality" Headsets are ideal for outdoor reception. They are ruggedly built, light in weight, neat in appearance and low in price. Every set is sold with a real, money-back guarantee. The purchaser must be satisfied.

If your dealer cannot supply you, order direct enclosing money order and address.

Attractive proposition to the trade.

RADIO SUPPLY COMPANY
HORNELL, NEW YORK

$25

Natural Re-PRODUCTION

The artist's presence can almost be felt in the startlingly natural Re-PRODUCTIONS by the *Atlas Amplitone.* Not a sign of blast or distortion, for the Amplitone, itself, is a fine musical instrument.

Designed by musicians, acoustic experts and radio engineers in response to the demand for an improved loud speaker. Many important refinements that increase the pleasures of radio without adding to its cost. A fine musical instrument applied to radio reception. Acknowledged supreme by highest musical and radio authorities.

Atlas AMPLITONE LOUD SPEAKER

Complete with connecting cord and full instructions for connecting and adjusting.

Insist Upon the Atlas Amplitone

Only the Atlas Amplitone can Re-PRODUCE. If your dealer has none, ask him to order for you.

Atlas Amplitone Unit

You can make your own loud speaker with this part of the *Atlas Amplitone* (without horn or base) and a horn of any phonograph, except the Brunswick. With phonograph attachment and instructions **$13.50**

Unit without Attachment, $12.50

WRITE for Illustrated Booklet

Multiple Electric Products Co., Inc.

Radio Division

7 Orange Street Newark, N. J.

This is the New DICTOGRAPH RADIO Loud Speaker

with The Adjustable Air Gap That Tunes Out All Harshness

Invite your friends tonight. Surprise them with a *real* concert or dance.

The wonderful new Dictogrand will create the illusion that the artists are in the very room with you. Just go to your dealer's and hear this remarkable, clear-toned instrument. Take it home and plug in for the finest entertainment you've ever known. You don't need extra batteries.

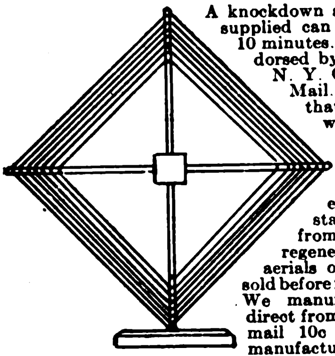
Like all the other famous Dictograph Products, the Dictogrand is guaranteed for one year.

If your dealer hasn't the DICTOGRAND in stock, write to us direct.

DICTOGRAND

Mahogany Finish $28.50

DICTOGRAPH PRODUCTS CORPORATION
220 W. 42nd St., N.Y.C.



RITTER LOOP AERIAL $1.00

A knockdown aerial. All parts supplied can be assembled in 10 minutes. Tested and endorsed by Popular Radio, N. Y. Globe and N. Y. Mail. We guarantee that the Ritter Loop will eliminate lightning and landlord trouble, reduce static, interference from sending stations and noises from your neighbors' regenerative sets. Loop aerials of this kind never sold before for less than $5.00. We manufacture and sell direct from our factory. By mail 10c extra. We also manufacture the now famous Ritter Grand Crystal Set which will tune up to 800 meters. Price $3.50. *Dealers write for our proposition.*

RITTER RADIO CORPORATION
232 Canal Street New York City

Wave Trap TRADE MARK
PATENT APPLIED FOR

The Missing Link in RADIO

Stops Interference!

The "WAVE TRAP" will eliminate interfering broadcasting stations and enable you to listen to your favorite station.

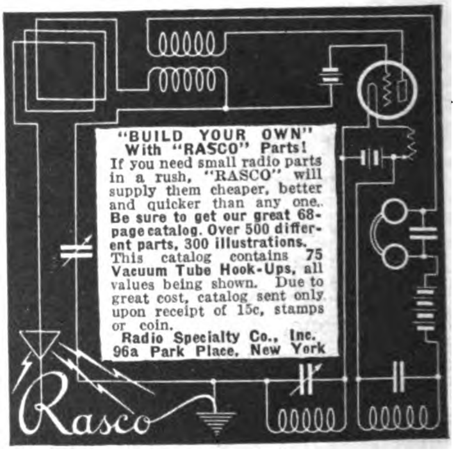
It will work on any set, greatly increase its selectivity and clearness, and eliminate code and spark stations.

It is mounted on a Formica panel in a handsome mahogany finished cabinet 6x5x6. It is a high grade instrument throughout and a valuable addition to the operation and appearance of any set. It comes to you complete and there are no extras to buy. It is installed in a minute by changing only one outside connection.

Use the "WAVE TRAP" for real results.

8.50 CHARGES PREPAID

Ferbend Electric Co.
21 E. SOUTH WATER ST.
CHICAGO
Circular on request



"BUILD YOUR OWN" With "RASCO" Parts!

If you need small radio parts in a rush, "RASCO" will supply them cheaper, better and quicker than any one. Be sure to get our great 68-page catalog. Over 500 different parts, 300 illustrations. This catalog contains 75 Vacuum Tube Hook-Ups, all values being shown. Due to great cost, catalog sent only upon receipt of 15c, stamps or coin.

Radio Specialty Co., Inc.
96a Park Place, New York

Rasco

ACME

for amplification

The City's Music In Vacation Times

Thousands of summer resorts are going to keep in touch with the world by radio. Thousands more will wish that they had thought of it.

The Jones *Symphony* Receiver, detector and three stage, is particularly fitted for this service.

Because: **FIRST, it is positively in a class by itself in the durability of its construction and assembly.**

SECOND, its simplicity of operation.

THIRD, its reliability.

We sell with the Jones *Symphony* Receiver, for this purpose, a stout traveling case. All you need to do is to disconnect your leads, put the *Symphony* in the case, turn the lock, put the case in your car with a couple of "B" batteries and you are all fixed. Use your automobile battery. If that isn't convenient, use "peanut tubes" with adapters. If you want the best, we suggest using regular tubes with a six volt battery. You can rent one at any town.

But in any case include a Jones Receiver in your summer outing plans. The *Symphony* will repay you many, many times over.

Summer radio has been handicapped by absurd stories of noises. The quality of our *Symphony* receiver, and more efficient broadcasting stations have eliminated many defects heretofore assumed to be caused by static. On most summer nights, especially in dry weather, the receiving is as good as at any other time in the year.

The use of the *Symphony* under many and varied conditions proves it to be one of the most efficient long distance receivers on the market. Every part of the *Symphony* is built and inspected by the Kellogg Switchboard & Supply Company, for twenty-five years manufacturers of highest grade telephone equipment.

Ask your dealer—If he has not a *Symphony* in stock, or complete information, wire us immediately. Get your order in at once to avoid delay.

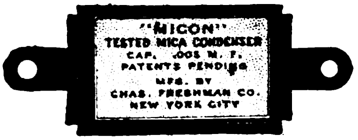
JONES RADIO COMPANY
LYTTON BUILDING, CHICAGO

The Symphony is manufactured under U. S. Patent No. 1113149, Armstrong Regenerative Circuit.

FLEWELLING-KAUFMAN-REFLEX ULTRA REINARTZ-NEUTRODYNE

and other circuits are greatly improved by using

"MICON" **TESTED MICA CONDENSERS**



Endorsed not only by experts, but by dealers, amateurs—in fact, every one interested in radio.

Because **The design of "Micons" is such that constant equal pressure is exerted on the condenser plates over the entire area. "Micons" assure absolute noiselessness, clarity of tone, accuracy, constant fixed capacity. "Micons" are invaluable as a protection against damage to the filament and their consequential short life.**

.006 Micon......	$1.00
.005 Micon......	.75
.001 Micon......	.40

Other "Micon" Sizes

.00005	30c	.0015	40c	.01	60c
.00025	35c	.002	40c	.015	2.00
.00035	35c	.0025	50c	.02	2.50
.0005	35c	.003	$1.50	.025	3.00

AT YOUR DEALERS—otherwise send purchase price and you will be supplied postpaid.

Ask for **FREE** *Diagram of* **KAUFMAN CIRCUIT**

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Ave. New York
Home of Freshman Variable Resistance Leaks

Ask for **FREE** *Diagram of* **FLEWELLING CIRCUIT**

The Best Headset

HIGHEST AUDIBILITY
PERFECT MATCHING
GREATEST VOLUME

Why Strain Your Ears?

T. B. H. Headsets reproduce clearly and naturally. No "Fuzz" or "Tinny" tone. Extremely sensitive.

Aluminum cases—6 Foot cord—Weight 12 oz.

Type 6-A 17500 Turns (2200 ohms) Hard Rubber caps	$7.00
Junior 16000 Turns (2000 ohms) Composition caps	$5.00

If your dealer does not carry them he will order them for you
Dealers and Jobbers write for discounts

THE T. B. H. CORPORATION
DANSVILLE, NEW YORK, U. S. A.

The Mutual Enjoyment of the FAMILY CIRCLE
BRISTOL'S AUDIOPHONE LOUD SPEAKER

A Loud Speaker and Reproducer in One

BRISTOL

TRADE MARK

AUDIOPHONE

REG. U. S. PAT. OFFICE

MORE THAN A LOUD SPEAKER the AUDIOPHONE is a real reproducer of the original broadcasting. It is easy to listen to the Audiophone reproductions because they are so perfect. The speech, songs and instrumental music are not blurred or disguised by mechanical distortion. You get all the fine shadings and every inflection. In fact, the very personality of the artist seems to be present as you listen.

DEVELOPED in the laboratories of an engineering firm known the world over for recording instruments of precision.

COMPLETE in every way and ready to connect to the receiving set.

NO AUXILIARY BATTERIES are required for magnetizing.

ADAPTED FOR use on all types of two or three stage power amplifiers.

MADE IN TWO MODELS—

BRISTOL AUDIOPHONE SR. Loud Speaker, Size of Horn 15 inches Diameter. Price............................$32.50

BRISTOL AUDIOPHONE JR. Loud Speaker, Size of Horn 11 inches Diameter. Price............................$22.50

THE BRISTOL SINGLE STAGE POWER AMPLIFIER for use with the usual two stage amplifier can be furnished, which will greatly increase the range of the Audiophone where desirable. Price.......................... $25.00

Write for Bulletin—3006-L

THE BRISTOL COMPANY **WATERBURY, CONN.**

Boston New York Philadelphia Pittsburgh Detroit Chicago St. Louis San Francisco

Here it is—the Perfect "Fishing" Record

EXPERIENCED radio operators have found a big advantage in keeping permanent records of their "catches."

White & Wyckoff's
Handy Radio Record
is the ideal record form.

It tells at a glance the code, location, ownership, wave length, date of every find. The sheets are perforated and can be taken from any part of the pad without disturbing the others.

Get this Handy Radio Record and keep a convenient and systematic record of your radio results. At your dealers or send us $1.00 for 5 pads of 50 sheets each, size 6"x9". Sent postpaid anywhere on receipt of price. Remit by check, cash or money order to

WHITE & WYCKOFF MFG. CO.
Makers of the famous Autocrat Stationery
100 Water Street
Holyoke, Massachusetts

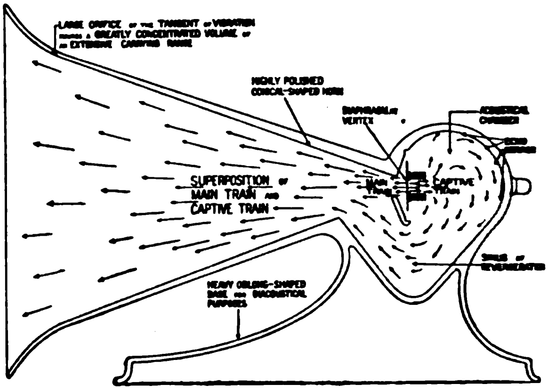
Your Radio Set on a

ROBBINS RADIO DESK

Presents an attractive appearance. All wires, batteries and other accessories are entirely concealed. Various finishes to harmonize with your furniture.

For sale by first-class radio and furniture dealers or write

Robbins Woodworking Co.
Dept. B
Libertyville, Illinois


HIGHLY POLISHED CONICAL-SHAPED HORN
DIAPHRAGM AT VERTEX
ACOUSTICAL CHAMBER
SUPERPOSITION OF MAIN TRAIN AND CAPTIVE TRAIN
MAIN TRAIN
CAPTIVE TRAIN
HEAVY OBLONG-SHAPED BASE FOR DIACOUSTICAL PURPOSES

ECHO-TONE

GIVES FIBRE NEEDLE TONE TO THE RADIO PHONE

A REAL PORTABLE LOUDSPEAKER

Unaffected by Climatic Conditions

NO PART TO BREAK OR JAR OFF

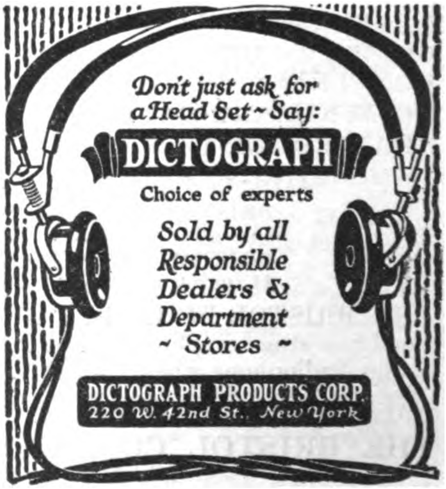
IDEAL FOR
Vacation, Outing or Travel

NO PULP to Crumble
NO WOOD to Warp
NO TIN to Bend
But
CASTED ALUMINUM for DURABILITY

Now Equipped With
A TONE REGULATOR

Retail Price $35.00

WILLIAMS RADIO COMPANY
Radio Tone Specialists
1438 Washington Blvd., Detroit, Mich.



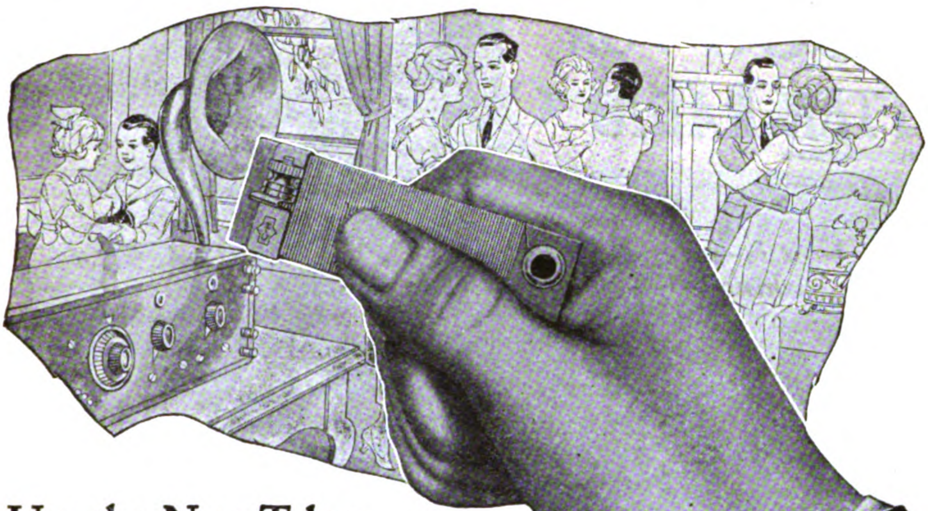
Don't just ask for a Head Set~Say:

DICTOGRAPH

Choice of experts

Sold by all Responsible Dealers & Department ~ Stores ~

DICTOGRAPH PRODUCTS CORP.
220 W. 42nd St., New York



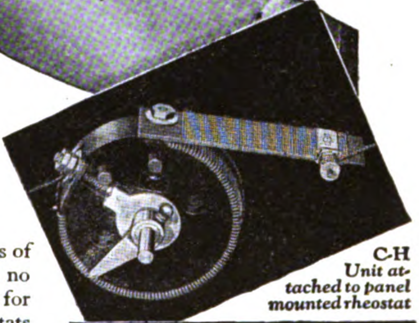
Use the New Tubes With Your Present Rheostats

The resistance of each of your present rheostats (4 to 6 ohms) is too low to control the new quarter ampere tubes (UV201A and C301A).

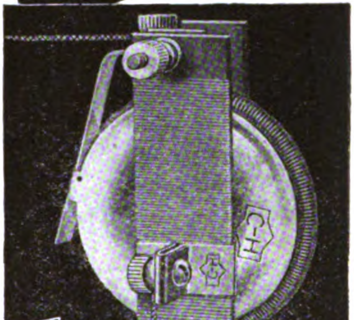
Cutler-Hammer engineers, however, have come to the assistance of the radio man once more and offer a small adjustable 25 ohm unit that can be attached to one of the posts of your present rheostat and with very little if any, wiring, and no loss of time, make it possible to use these new and better tubes for maximum results. It makes "junking" of your present rheostats unnecessary and saves the trouble and expense of redrilling your panel for new ones.

The C-H Radio Resistance Unit is arranged for use with all makes of rheostats and for panel mounting. This new unit increases the range of your 0-5 ohm rheostat to 0-30 ohms, the slider being adjustable over the entire range to care for changes in battery potential. After once set, this adjustment requires practically no attention and regulation of the tube is obtained entirely by turning the rheostat knob.

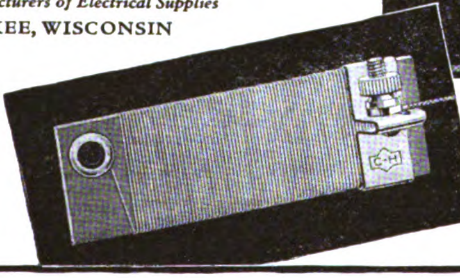
THE CUTLER-HAMMER MFG. CO.
Member Radio Section,
Associated Manufacturers of Electrical Supplies
MILWAUKEE, WISCONSIN



C-H *Unit attached to panel mounted rheostat*



C-H *Unit attached to standard* C-H *Rheostat*



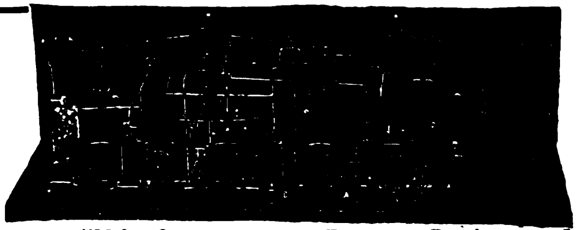
C-H *Unit mounted on post fastened to panel; then wired in series with rheostat. Easy, neat, effective mounting*

Carried by dealers everywhere. If yours has not been supplied, send 25c *direct plus* 10c *for mailing*

C-H
CUTLER-HAMMER

RESISTANCE UNIT
FOR RADIO RHEOSTATS

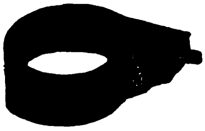
"AMSCO FOR BETTER RADIO"



"Melco-Supreme" Radio-Frequency Receiver

Audio-Frequency Transformer

FROM the Melco Supreme Radio Frequency Receiver, down to the smallest Inductance Switch or Binding Post, Amsco Products are known the world over for their scientific correctness, mechanical perfection and ruggedness of construction. You'll buy Amsco Products on their appearance, but keep them because of their durability and dependability.



Honeycomb Coil and Plug

Write for our Booklets Nos. 1001 and 1002 illustrating and describing our entire line of quality apparatus.

Honeycomb Coil Mounting

AMSCO PRODUCTS, Inc.
Fairbanks Building
Broome and Lafayette Sts., New York City
Successors to Mortimer Radio Corporation
Advance Metal Stamping Company

Audio-Frequency Amplifying Variometer

OPEN

RADIO CABINET

WILL FIT ALL RECEIVING SETS
MAHOGANY PIANO FINISH
PRICE $60.00

DEALERS AND JOBBERS
Write for Our Proposition

PETERS ELECTRIC CABINET CO.
HORNELL, N. Y.

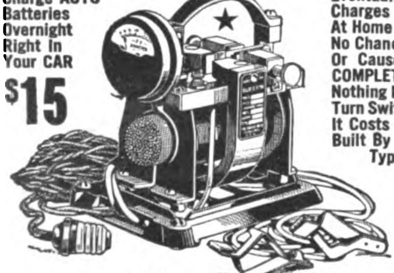
CLOSED

F-F BATTERY CHARGER

CHARGES RADIO "A" & "B" & AUTO STORAGE BATTERIES at HOME Overnight, for a Few Cents From Any 100 to 130 Volt 60 Cycle A. C. Lamp Socket.

All TYPES But "B" Charge AUTO Batteries Overnight Right In Your CAR

$15



CHARGE RADIO & AUTO BATTERIES.

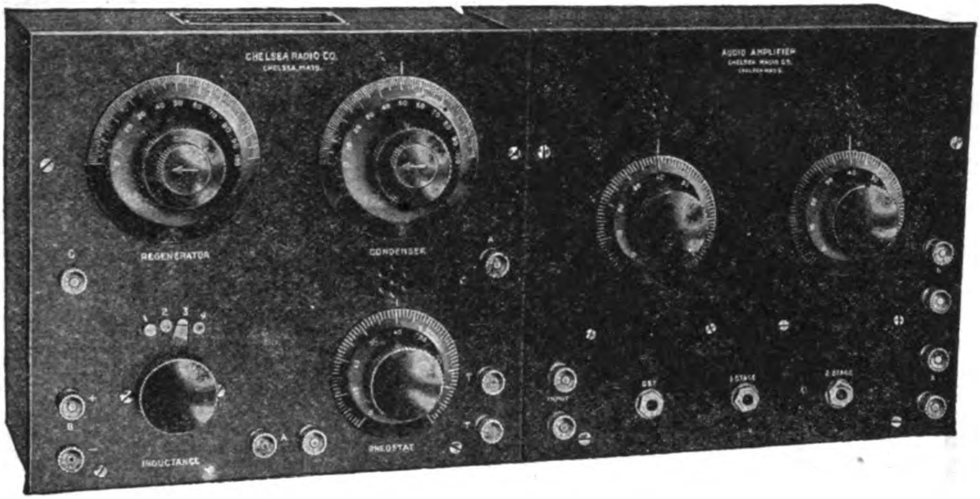
F-F AUTOMATIC MAGNETIC TAPER CHARGE DESIGN made BATTERY CHARGING POPULAR. Eventually You Will Buy An F-F CHARGER & The Sooner You Buy One; The More You Save. A-B Charges All 6 Volt & up to 120 Volts Of "B" & Loud Speaker Storage Batteries In Series Inductively At Home Overnight. Disconnecting & Multiple Connections Unnecessary. Charging Circuits Separate. No Chance For Grounds, or Short Circuits. Nothing To Slop Over, Be Filled, Burn Out, Need Attention Or Cause Trouble. Infusible Rectifying Brushes Maintain Constant Efficiency Uninterruptedly. COMPLETE PORTABLE AUTOMATIC. No Skill Required. AMMETER eliminates Guess Work. Nothing Like It Made. Lasts A Lifetime. Screw Plug In Lamp Socket; Snap CLIPS on Battery Terminals; Turn Switch & Battery Is Charged In Morning. Charged Batteries Mean Fewer Expensive Replacements. It Costs Less To Buy An F-F CHARGER Than To Be Without One. INSIST on The F-F CHARGER. Built By A Master Of The Art In 7 TYPES. Thousands Sold Make Possible These POPULAR PRICES

Type6charges6VoltBatteryAt6amperes$15 Type12charges12VoltBatteryAt5amperes$15
TypeBchargesRadio"B"BatteriesUpto120Volts$15 TypeA-BisCombinationOf6&B$20
Type166charges6VoltBatteryAt12amperes$20 Type1612charges12VoltAt7amps$20
Type1626 is a Combination Of Types 166 & 1612 and Charges Both 6 & 12 Volt Batteries $28
Types B & A-B are Radio Specials. Types 166, 1612 &1626 are For Heavy & Rapid Charging.

SHIPPING WEIGHTS Complete with AMMETER & BATTERY CLIPS 11 to 15 lbs. PURCHASE from DEALER; Mail Check, or WRITE us to Ship TYPE desired C. O. D. ORDER Now, or WRITE Immediately for Free Descriptive CHARGER Bulletins 44 & 44A.

FRANCE MFG. CO., Cleveland, Ohio.

IMPROVED



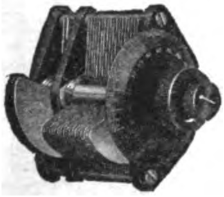
REGENERATIVE RECEIVER

Licensed under U. S. Patent No. 1113149 for Amateur Use Only

Range 150 to 750 Meters **Vernier Controls**

Receiver $45.00
Amplifier $35.00

Dealers:---Write for Our New Proposition



No. 8 $6.50

Vernier Condensers

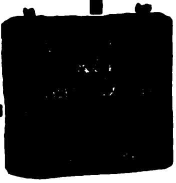
12 Models
$2.50 to $6.75

Write for Bulletin No. 7

No. 7 $6.75

CHELSEA RADIO CO.

177 Spruce Street **Chelsea, Mass.**



ACE

THE FINEST IN BATTERY PRODUCTION

THE best does not always mean the most expensive, for Ace Batteries sell at a price that meets with instant favor, yet the quality far surpasses anything on the market.

Ace Batteries are different. They have higher voltage to carry them thru conditions of greatest current drain.

Radio "A" Batteries

made in several types of 1 to 4 cellpower, 1½ volts and 6 cellpower, 4½ volts for W-D 11 tubes.

Radio "B" Batteries

made in several types for every existing condition.

Dealers: We have a wonderful proposition for you. Write

The Carbon Products Co.

Lancaster, Ohio

Manufacturers all kinds of Dry Batteries, Carbon Brushes, Welding Carbons, etc.

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11-19 Moore St.
New York, N.Y.

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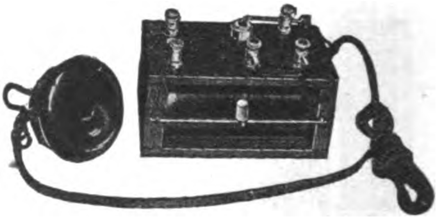
Minneapolis, Minn.

1001 Main St.
Dallas, Texas



"VB" RADIO CRYSTAL SET

An inexpensive, efficient radio receiving set. Has surprisingly loud, clear tones. Is extremely simple to operate. Receives up to 550 Meters within a radius of 25 Miles.

Without phone or antenna . .	**$1.50**
With single phone (1400 ohms) receiver and cord	**$3.50**
With double headset (2800 ohms)	**$5.75**

Antenna Equipment for the above set 50c extra.

Satisfaction Guaranteed or Money Refunded

Sent prepaid to any address upon receipt of money order or will send C. O. D. parcel post.

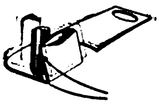
Dealers write for proposition.

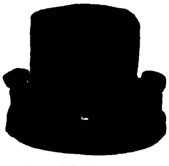
Manufactured by

B. W. WHITEHURST

250 South Street
Newark, N. J.

Na-ald Special Socket
No. 499





Na-ald De Luxe
No. 400

It's the contact that counts

The dual-wipe contact strips of the Na-ald De Luxe socket avoid the trouble experienced with the socket of conventional design. Because of thorough cure and high dielectric properties this socket keeps plate to grit losses at a minimum (of particular importance in Flewelling Circuit or in Radio Frequency).

Price 75 cents

The Na-ald Special Socket No. 499 is a sturdy little socket for the G. E. No. 199 dry-cell tube. It has special slot construction, and is moulded of genuine Bakelite. The heat from soldering connections will not affect these sockets.

Price 50 cents

Booklet with wiring design and instructions for Hazeltine's Neutrodyne circuit, together with other selected circuits, packed with each Na-ald product or sent in exchange for cover taken from any Na-ald carton.

Alden Manufacturing Co.

formerly

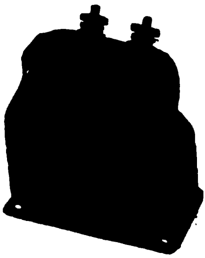
Alden-Napier Co.

Dept. C **52 Willow St.**
Springfield, Mass.

RADIO PRODUCTS NA-ALD

RADIO FREQUENCY

R-10 (150-550 meters) $4.50



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R-12 (Ratio 3 to 1)	$4.50
R-13 (Ratio 10 to 1)	4.75
R-21 (Ratio 5 to 1)	4.75

Your Dealer Probably Has

"All-American" Amplifying Transformers

(RADIO and AUDIO Frequency)

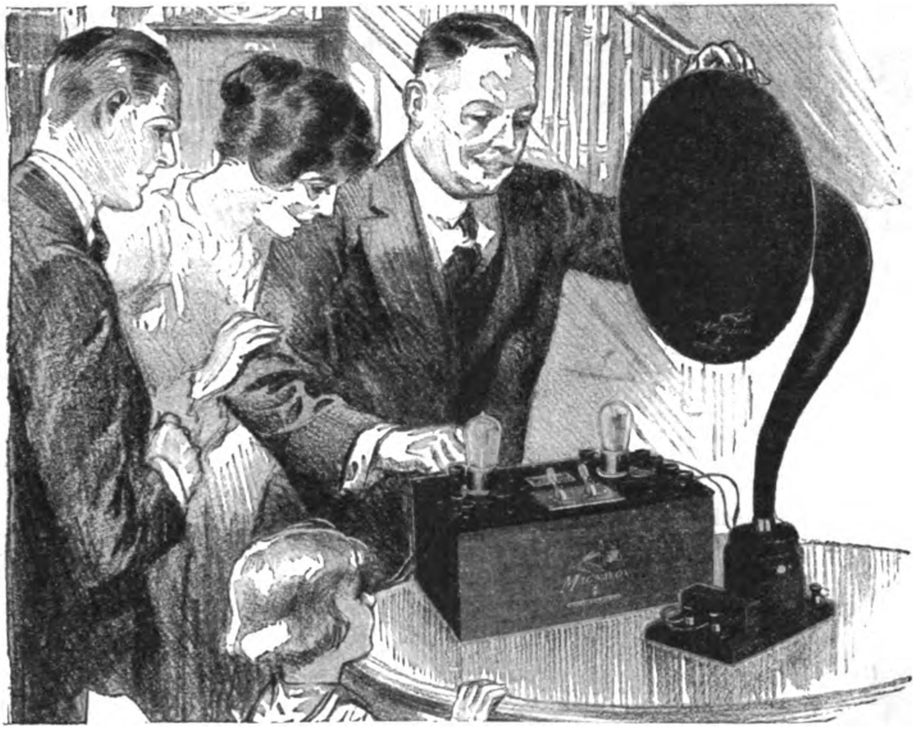
If he has thus far missed these highly important aids to clear strong radio reception, tell him you'll buy "All American" or nothing.

They cost no more; and your set is entitled to the best the art has produced. **Our Radio Frequency Transformers** should be used to amplify radio frequency impulses before they reach the detector tube and the **Audio Frequency Transformers**, to strengthen the detected signals. The combination of the two forms the ideal long-distance radio reception hookup for either headphone or loudspeaker reproduction.

Ask your dealers **first** before you write. If none of them can supply you, send orders to us with name and address of Dealer you wish to favor, and transformers will be sent you postpaid at the prices named. **FREE Hand Book of Radio Hookups**—25 up-to-date diagrams of Successful Circuits. Send 2c stamp to cover postage.

RAULAND MFG. CO.

200 No. Jefferson St., Chicago, Ill.



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The Magnavox Reproducer and the Magnavox Power Amplifier

THE efficiency of Magnavox Radio apparatus is best realized by comparison with other instruments constructed on less modern scientific principles. When operated in accordance with instructions, satisfactory results are assured.

Magnavox R3 Reproducer and 2 stage Power Amplifier (as illustrated) $90.00

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Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Reproducer

2 stage $55.00
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Magnavox Products can be had from good dealers everywhere. Write for new booklet.

THE MAGNAVOX COMPANY
Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

No Radio Receiving Set is complete without them

6-T

$10

Your phone plus
FIBERTONE
equals a clear
LOUD SPEAKER

Now is the time to prepare your radio equipment for use during the vacation months. Enjoy your summer with radio, end those screechy, vibrative sounds so common to metal horns, and amplify every word or note into clear, bell-like tones with a Fibertone horn plus one of your phones. Besides perfect action, Fibertone horns are beautiful, their surface being finished in a black crystalline.

If your dealer can't supply you write direct to

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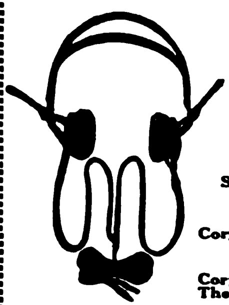

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"RADIO" HEADSETS
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Coryphone "Radio"
Double Receiver
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3200 OHMS, $9.50
2000 OHMS, $8.00

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The world's finest reproducers. Coryphones have many exclusive features and are best by comparison. Ask your dealer to demonstrate these remarkable values.

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for W.D.11 tubes—

Standard, threaded rubber, Willard's, specially adapted for use with W. D. 11 tubes. Supply current at 2 volts to one W.D. 11 tube for 210 hours on a single charge. Rechargeable. Brand new, size 4x5½x7 inches—Chi-Rad guaranteed.

This is a time and quantity limited offer—orders will be filled, first come, first served. Get yours first by ordering now!

2-Volt Willard Charged . . $7.50
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Chicago Radio Apparatus Co.
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Radio **PATHFINDER** *& Wall Map*

INTERESTING

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"Pathfinder Gauge is all the Rage"

How far will your set reach?

Air-Line "DISTANCE" in Meters and Miles from your HOME anywhere to all Broadcasting stations in the U. S. The PATHFINDER GAUGE does it. Use the GAUGE and "Tune in" the Station. Gauge complete with *Wall Map* 36"x24" showing location, call letters and wave length of Broadcasting Stations, Standard Time Zones, radio districts, and other valuable information. No set complete without this outfit. Mailed prepaid, rolled in tube with full instructions.

Heavy paper $1.00
Cloth Mounted $2.00
(DO NOT SEND STAMPS)

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General Radio Type 300 Amplifier Unit—

Works equally well with crystal or tube detectors. Is a compact unit, wired ready for external connections. Two or more units may be used together to obtain multi-stage amplification.

Prices

Type 300-A Amplifier Unit for WD-11 Tubes, complete except for tube and batteries, **$7.50**

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Type 231-A Transformer —*Gives the maximum amplification possible without distortion. Like all Amplifying Transformers manufactured by The General Radio Company, the Type 231-A is guaranteed.*

Price **$5.00**

General Radio Type 214 Rheostat—

A convenient, practical instrument, equally well adapted for experimental service or permanent installations. You'll never cause unpleasant noises in the phones when you rotate the contact arm of a Type 214 Rheostat.

Price

For the new UV201-A Tubes, 20 Ohms.
For the newer UV199 Tubes, 20 Ohms.
For the Standard Tube, 7 Ohms.
$2.25

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To get your gas detector on that sensitive kink by fine adjustment of the plate potential, use this General Radio 400 Ohm Potentiometer. It will control regeneration in your radio frequency amplifier by a positive grid bias.

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Bring your problems to us. Our Engineering Staff is always at your disposal.

For more than eight years, among men who know and use Radio Apparatus of the better sort, the name—General Radio Company—has been accepted as a guarantee of all that goes to make up satisfaction and as synonymous with the advances in theory and practice which accompany all true Radio progress.

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If you are interested in Radio Apparatus in which price is subordinated to satisfaction, send for Bulletin 914 U. It is an educational pamphlet for the amateur who wants better equipment.

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Radio and Electrical Laboratory Apparatus
Massachusetts Avenue and Windsor Street
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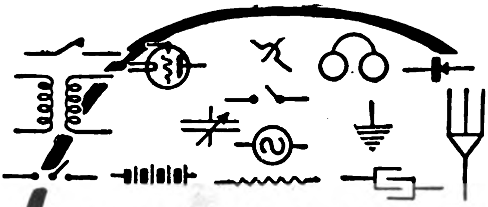

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Radio units work best on Bakelite-Dilecto (xx grade) panels and bases. This wonder-material gives absolute insulation and has tremendous mechanical strength.

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(A Laminated Phenolic Condensation Product.)

Highest in dielectric strength. Tough, durable, yet readily machined. Keeps its shape, color and glossy finish always. Resists heat, water, steam, fumes and solvents. Used in the U. S. Navy and Signal Corps nearly NINE YEARS!

Don't rush ahead with "just anything" for a panel. Get real Bakelite-Dilecto (xx grade) and you'll get best results.

THE CONTINENTAL FIBRE CO.
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Regal No. 140 Filament Rheostat

Has full exposed resistance wire, giving critical adjustment so necessary to the efficient operation of a vacuum tube. Fine, smooth working control. Handsome knob, heat resistance base and highly nickel-plated parts. 6 ohms resistance—2.2 amperes.... $1.00

The Big "Regal" Line

Power Rheostats, Potentiometers, Inductance Switch, Variocoupler, Tube Sockets, Jacks, Condensers, Knobs, Dials, etc. Send for Catalog No. 27.

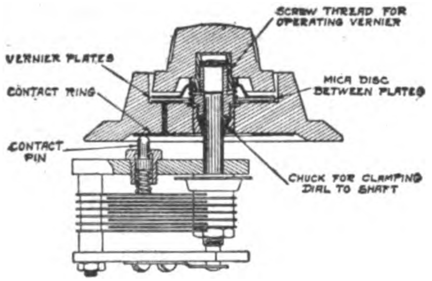
(If your dealer does not handle Regal Products —write us direct)

"Regal" Inductance Switch

A 15-point switch complete in one unit. Requires but one hole to mount on panel. Smooth wiping contact over heads machined to same height on one piece contacts. Complete soldered assembly attached, or removed from panels by means of one threaded shaft bushing. Gives inductance regulation by dial contact............. $2.00

The American Specialty Co.

Bridgeport, Conn.


SCREW THREAD FOR OPERATING VERNIER
VERNIER PLATES
CONTACT RING
MICA DISC BETWEEN PLATES
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NEW "UNITED" VERNIER

Dial Assembly

More Power, and Far Greater Selectivity

Large capacity, due to the large area of the mica-insulated copper vernier plates.

Great Fineness of tuning, due to the delicate screw thread adjustment of Vernier

Short-circuiting rendered practically impossible. Note that the opposing circuits are located *in the knob and Dial*—a new and better way.

This new United Vernier Dial Assembly can be attached to any plate condenser, it being necessary to drill only one hole.

Price, Postpaid........$2.50

UNITED VARIABLE CONDENSERS
WITH NEW TYPE VERNIER DIAL ASSEMBLY

43 plate	$6.50	5 plate	$5.00
23 plate	6.00	3 plate	4.75
11 plate	5.50		

"UNITED" AMPLIFYING TRANSFORMER. Audio Frequency magnetically shielded. Fine piece of precision workmanship. Ratio 5 to 1. Each, $4.50.

All United Products are sold under a positive money-back guarantee. When you remit or write for circular, give us the name and address of your favorite Radio dealer.

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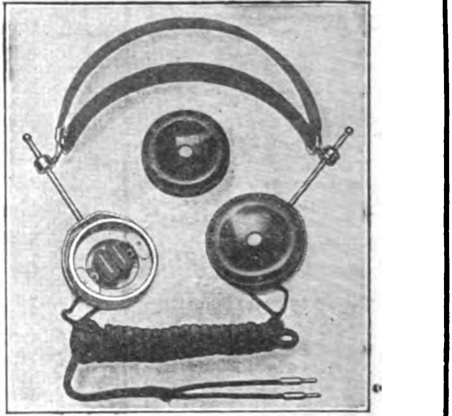
AMPL-TONE PHONES



2200 Ohms—$6.00

AT LAST, the public may have these EXCELLENT Headsets at a popular price. Positively the equal of the expensive phones, for beauty, comfort, tone and durability.

Money back guarantee protects you. "Wonderful value," "Equal to $12.00 phones," and other testimonials on file.

Write for special prices for a limited period

DEALERS: Get in on our special advertising and extreme discounts. One sample for $3.00 cash.

C. M. FRENCH MFG. CO.
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Two thousand, three thousand, four thousand miles and more away—stations in every direction contribute to the daily pleasure of MU-RAD owners. The extraordinary sensitivity of these receivers, using only a two-foot, indoor loop aerial, provides continually new thrills and surprises. Remarkable clarity. Selects with astonishing distinctness. Easiest imaginable to operate. Nominal guarantee of 1000 miles reception.

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The New Star in the Radio World

MU-RAD LABORATORIES, INC.

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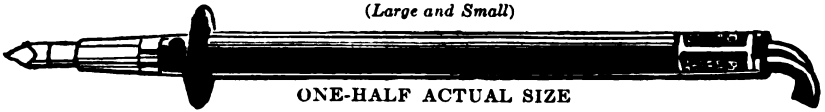
DELICATE SOLDERING in RADIO

Both the manufacturers' and amateurs' problem on all fine work is readily solved by the instrument constructed for this particular purpose.

THE POST SOLDERING IRON

Platinum Heating Unit—Interchangeable Tips—Universal Current

(Large and Small)



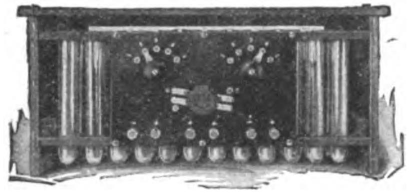
ONE-HALF ACTUAL SIZE

$6.00

Awarded Certificate of Excellency, N. Y. Evening Mail Radio Institute

From your Dealer, or write

POST ELECTRIC COMPANY (Instruments Division), 30 E. 42nd St., New York



KICO Storage "B" Batteries give long service at low cost

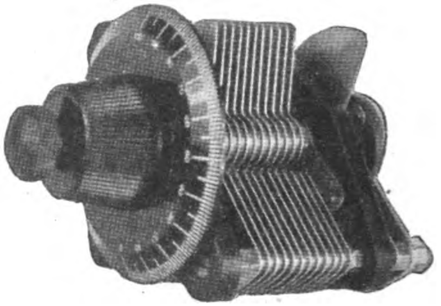
Alkaline type, will not sulphate or buckle. Not harmed by short-circuiting, overcharging, or standing idle. Panel switches afford single cell variations. Easily re-charged from any 110-volt A.C. line by means of small home rectifier. One charge lasts three to six months in detector plate circuit.

Prices without rectifier:	Plain	(With Panels)
16 cell 22 volt	$5.50	
24 cell 32 volt	$7.25	$11.75
36 cell 48 volt	$9.50	$14.00
50 cell 68 volt	$12.50	$17.00
78 cell 100 volt	$17.50	$22.50
108 cell 145 volt	$23.50	$28.50
Unmounted rectifier	$1.00	
Mounted rectifier	$2.50	

SATISFACTION GUARANTEED

Money is refunded if user is not satisfied after 30 day trial. Write for full information on "A" and "B" Batteres.

KIMLEY ELECTRIC COMPANY, Inc.
1357 FILLMORE AVENUE BUFFALO, N. Y.



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VARIABLE CONDENSERS

Standard Constructions, Aluminum Plates, Moulded Ends, Accurate Spacing. Plain or Vernier.

LIST PRICES

11 Plate, Plain	$3.00		
23 Plate, Plain	$4.00	Vernier	6.50
43 Plate, Plain	4.50	Vernier	7.00
Vernier Only	1.75		

Manufactured by
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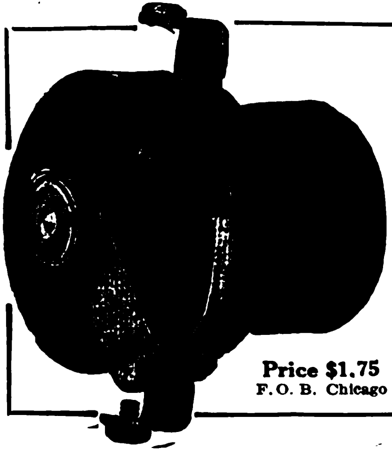

Price $1.75
F. O. B. Chicago

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An Improvement on the Jenkins Rheostat

A Single Wire in a **Groove,** followed by a point **constantly** in **contact,** gives **noiseless** adjustment, and permits of infinitesimal refinement in tuning.
A Cut-Out Switch operates with no change in adjustment, permitting a set to be turned on and off by the **Rheostat** with **absolutely no change in tuning.**
Manufactured in any resistance. 6 ohm and 25 ohm carried in stock. Guaranteed for one year.

THE UNITY MFG. CO., 224 No. Halsted St., Chicago, Ill.

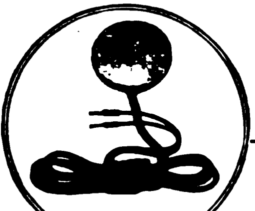
"Hear a set that uses one"

14-inch Home Model, **$30**
21-inch Concert Model, **$35**

In your home, you hear the same sweet tones of the same violin, played on the stage or broadcasting room at the same instant.

Music Master
RADIO AMPLIFIER

The Instrument of Radio Realism



Geraco Phonograph Attachment

Converts your Victrola or Columbia into an efficient loud-speaker. Complete, $10. For sale through jobbers and dealers everywhere.

JOBBERS
DEALERS

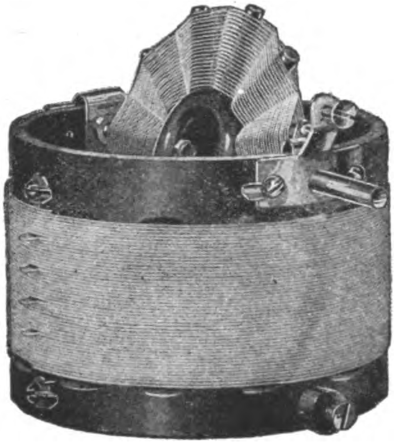
A MUSIC MASTER will be sent you with full privilege of return. Write for full description of the GERACO Line and prices.

The horn of MUSIC MASTER is *wood,* for the same reason a violin is wood. MUSIC MASTER gives more than a reproduction; more than a re-creation; it IS the artist himself, in the pure, mellow-sweet tones of ACTUALITY!

Not a mechanical device, but a musical INSTRUMENT. It does not squawk, vibrate or twist tone. Experts on acoustics, in long study, have eliminated reproducer-faults and the result is the *perfect* MUSIC MASTER.

Comes complete, ready to attach in place of headphones. No extras to buy. Hear MUSIC MASTER at the home of a radio-friend or at your dealer's. Let it talk for itself!

GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus
CHICAGO
PHILADELPHIA
S. W. Cor. 10th & Cherry Streets
PITTSBURGH



HARTMAN VARIOCOUPLER

WITH

SPIDER WEB ROTOR

PROVIDES

REMARKABLE SELECTIVITY IN TUNING

Designed for us by Alfred A. Crossley

Price $6.50

Write for bulletins on Hartman Radio Products

THE HARTMAN ELECTRICAL MFG. CO.
MANSFIELD, OHIO

McNEARY

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Radio Map and Broadcasting Directory

EVERY RADIO FAN NEEDS IT

You have just tuned-in a distant station. Of course you want to know how far it is. With the Scalometer mounted on the accompanying map you have the answer at a glance—instantly and correctly.

A Scalometer tells

RANGE OF YOUR SET	DISTANCE OF ALL D-X CALLS

If your dealer can't supply you, send one dollar to

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251 Middle City Bldg.
Philadelphia

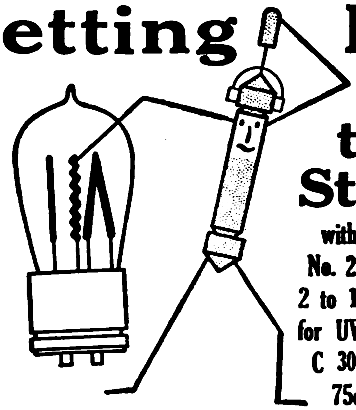
SCALOMETER
An instrument of precision in a beautifully finished aluminum case.

RADIO MAP
Authoritative, up-to-the minute, showing broadcasting stations, time zones, radio districts, cities and towns in U. S. and Canada.

BROADCASTING DIRECTORY
In handy booklet form with broadcasting stations alphabetically arranged by call letters.

ALL THREE
$1.00

Getting DX thru Static



with the new No. 201A Special 2 to 10 megohms for UV 201A and C 301A Tubes 75c each

Tuning for DX—distance stations—is greatly helped by keeping the tubes as quiet as possible. This means *variable* resistance in the grid circuits—DURHAM Variables, with the plunger adjustment. Try them and get rid of a lot of trouble from static.

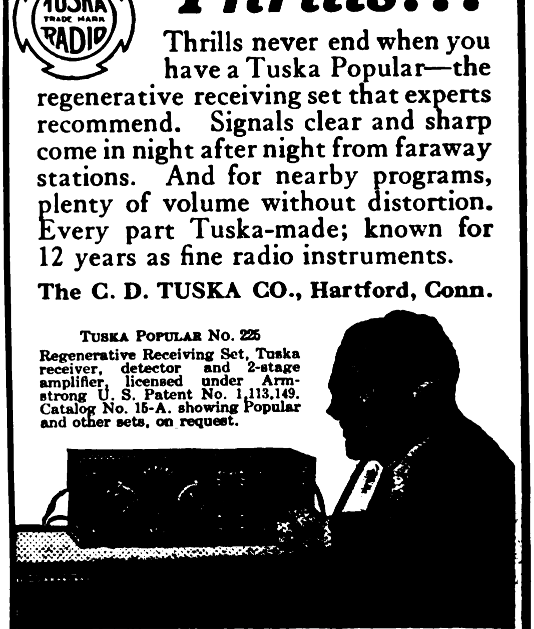
DURHAM & CO., 1936 Market St., Philadelphia

Durham Variables High Resistance

Thrills!!!

Thrills never end when you have a Tuska Popular—the regenerative receiving set that experts recommend. Signals clear and sharp come in night after night from faraway stations. And for nearby programs, plenty of volume without distortion. Every part Tuska-made; known for 12 years as fine radio instruments.

The C. D. TUSKA CO., Hartford, Conn.



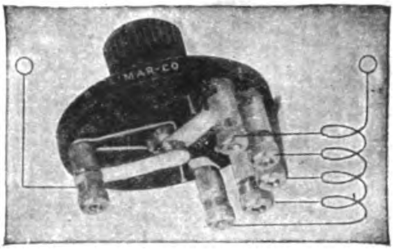
TUSKA POPULAR No. 225
Regenerative Receiving Set, Tuska receiver, detector and 2-stage amplifier, licensed under Armstrong U. S. Patent No. 1,113,149. Catalog No. 15-A. showing Popular and other sets, on request.

TUSKA RADIO

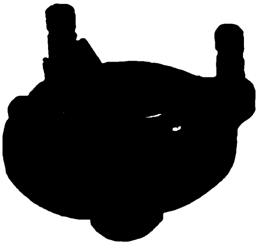
All-Ways Better MAR-CO

MAR-CO RADIO PRODUCTS

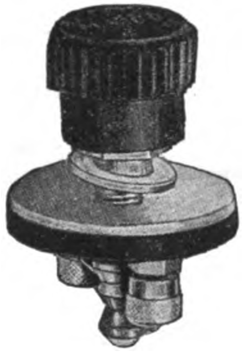
Mar-co Inductance Switch



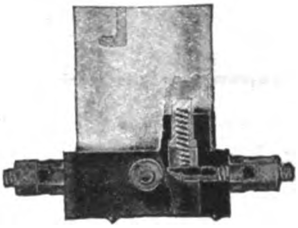
MAR-CO INDUCTANCE SWITCH. The finest on the market. Small. Finely made. Exclusive features. No loose connections. Perfect contact at every tap. Only one hole in panel necessary for rigid, secure mounting. No special tools necessary for trouble-proof connections—just ordinary pliers. The only inductance switch with *separate positive locking arrangement* for seating switch arm in proper place on contact. This locking action is felt upon turning knob. Prices, including attractive dials and Bakelite Knob with imbedded brass bushing—5 points, $1.00; 7 and 9 points, $1.25; 11 points, $1.50; 13 points, $1.75.



MAR-CO VERNIER RHEOSTAT will bring the most critical tube to the highest point of efficiency by means of an extremely delicate adjustment. 6 ohms resistance—2 amperes capacity. Calido-nickel-chromium Resistance Unit, and Bakelite Base and Knob. Price, $1.50.



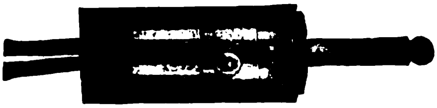
MAR-CO FILAMENT SWITCH. Type 400-A. Insures maximum efficiency from batteries by disconnecting them from set when not in use. Mounts through one drilled hole and presents a fine appearance. Price, $0.90.



Our new UV199 cushion socket provides the resilient non-microphonic mounting necessary to protect the delicate, fragile filament of the new UV199 tube. Unexcelled for neatness, small size, positive electrical contact and mechanical perfection. Hard Rubber Insulation. Price, $0.75.

MAR-CO JACKS. Short circuit impossible. Highly nickeled. Formica insulation. Sterling silver contacts. Extra washers allow wide range of panel adjustment. Price,

No. 3 Single Open Circuit	$0.65
No. 4 Single Closed Circuit	.75
No. 1 Double Circuit	.90
No. 5 Single Filament Control	1.00
No. 6 Double Filament Control	1.10



STA-PUT PLUG. Fits any tip. No tools necessary to fasten. Instant connection or disconnection. Mechanically correct. Finely made and finished. Price each, $0.60.

Martin-Copeland Company

Providence, R. I.

1200 MILES
with a Crystal Set Using

MPM
MILLION POINT MINERAL
THE WORLD'S GREATEST RADIO CRYSTAL

A Needles, California, radio fan writes:

"Using M. P. M. Crystal, I picked up Los Angeles, San Francisco, Salt Lake, Denver and St. Louis. It is far superior to any crystal I have ever used."

Before discarding your Crystal Set for an expensive Tube outfit, give M. P. M. Crystal a trial!

¶ ***Beware of imitations!*** The genuine Million Point Mineral is sold only in separate crystals packed by our company in boxes bearing the trade-mark "M. P. M."

Send 25c and name of your Radio Dealer for a sample M. P. M. Crystal—concert-tested and guaranteed. 35c for mounted Crystal.

M. P. M. SALES COMPANY
Department PR
247 So. Central Ave. Los Angeles, Cal.

Warren Radio Loop, cut away to show construction

WARREN RADIO LOOP

Make Your Set Portable for Camping and Vacation

CONTINUE to enjoy the radio programs on your camping trip or wherever you spend your vacation. A Warren Radio Loop allows you to take your set anywhere. Sizes as small as 6 inches square, that can be fitted inside your cabinet. Send a postal for our Bulletin I-102, containing hookups.

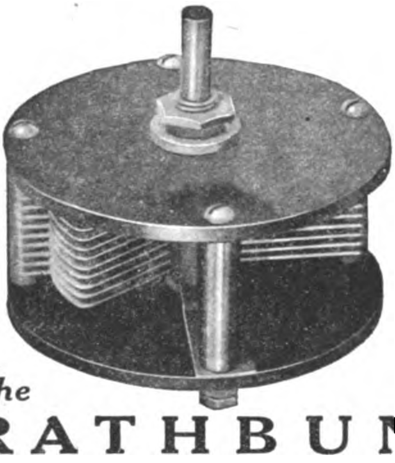
A Type for Every Set at the Best Dealers

Type A-737 (300-700 meters) 6 inches square—non-directional	$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional	$12
Type B-2537 (300-700 meters) 18 inches square—directional	$20
Type BL-2520 (200-18,000 meters) with honeycomb coil. 18 inches square—directional	$25

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

It's a Winner!



The
RATHBUN
SINGLE HOLE MOUNTING
CONDENSER

This Variable has won the heart of Rado Fans everywhere—Why? Because it is different and better. Its construction is perfect throughout.

(1) Only 1 hole to drill for mounting.
(2) Plates die-cast in milled brass tubes.
(3) Formica ends for plate protection.

Vernier, 11 plate, 23 plate and 43 plate at your dealers or direct from

Rathbun Mfg. Co., Jamestown, N. Y.

Listen in with

Dodge TONE AMPLIFIER

A scientifically perfect instrument, with wood pulp sound chamber, designed by one of the foremost acoustical specialists. This Perfect Tone

RADIO LOUD SPEAKER

insures the most delicate reproduction of voice or music and positively eliminates distortion and metallic sound.

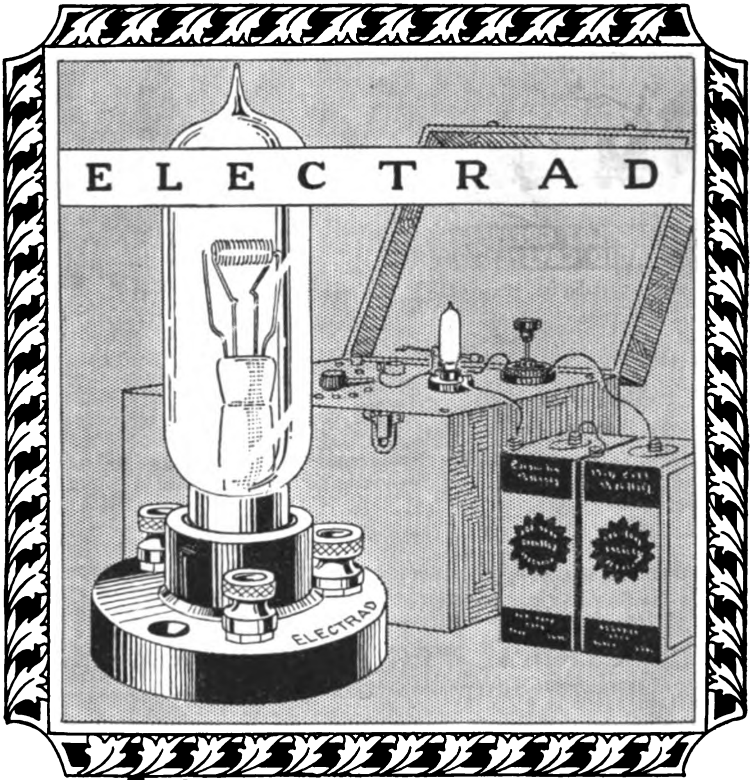
The Dodge Tone Amplifier is enclosed in a handsome mahogany cabinet, with front panel and sound chamber finished in black. Size of complete outfit: 12 in. high, 9¾ wide, 8¼ in. deep.

The Dodge Tone Amplifier is made especially for home use, with any set of three tubes or more. No batteries necessary. No adjustments. Complete, ready for immediate use. Merely hook up and listen. Price....... $25.00

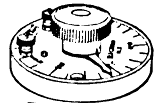
Model No. 10

Liberal Discounts to Jobbers and Dealers

ACKERMAN BROTHERS COMPANY, Inc.
Dept. "PR," 301 W. 4th Street. New York, N. Y.



Diode A DRY CELL TUBE FOR $2



VARIOHM

Variable high resistance unit, 1/10 to 5 megohms. Does the work of a thousand grid leaks. Contains standard mica condenser of proper capacity. Bakelite. Price complete $2.00

Something new in radio. Diode! A two element vacuum tube that is more sensitive than a crystal. Diode does the work of a high priced instrument and eliminates the use of storage and "B" batteries. Its reception of word and note is absolutely without howl. The low cost of Diode and its economical operation turns radio into an inexpensive luxury.

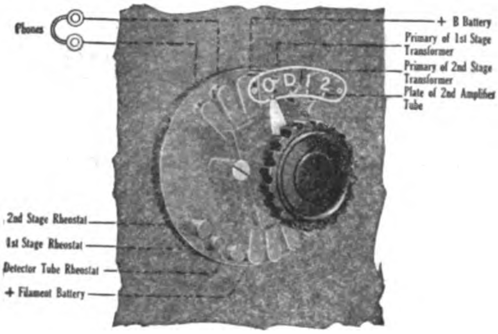
Tube with socket $2.50. Ask your dealer or write direct, sending dealer's name and 10c. postage.

Branch Offices

C. H. Wallis & Co., 1409 Syndicate Trust Bldg., St. Louis, Mo.
802 Forsyth Bldg., Atlanta, Ga.
703 Granite Bldg., Pittsburgh, Pa.
1028 Fourth Ave., Huntington, W. Va.
709 Mission St., San Francisco, Cal.
337 S. Western Ave., Los Angeles, Cal.
Munsey Bldg., Washington, D. C.
1121 Pine St., Seattle, Wash.
53 W. Jackson Blvd., Chicago, Ill.
1403 Monadnock Block, Chicago, Ill.
636 Victory Bldg., Philadelphia, Pa.
1011 Chestnut St., Philadelphia, Pa.

ELECTRAD CORPORATION OF AMERICA
428 Broadway, New York

FIL-FONE CONTROL SWITCH



Price $3.00

Protected by Patents Pending

Dispenses with jacks and plugs. Saves money in building sets. Positive and progressive control of filaments.

Send for circular F. F. S., No. 2 for complete description

DISCOUNTS ON APPLICATION

(Complete Radio Catalog sent on receipt of 6c for mailing)

The A-C ELECTRICAL MFG. CO.
Dayton, Ohio

U. S. Bureau of Lighthouses Indorses

SPIDER WEB COILS

Turney's Spider Web Plex Coils are taking first place in the Radio Field, eliminating the variocoupler as a tuning unit and making child's play of station finding.

Wave length range—960 meters with condenser in shunt. No body capacity.

Eugene T. Turney's patent on Spider Web Winding is the only one granted by the Government. They are wound on automatic machines—also patented, making absolute uniformity certain.

See your dealer, or mailed direct on receipt of $4.50, cash or money order (no stamps or checks). Hookups for tube and crystal sets included.

TRISTAN SALES CORPORATION
Sole National Distributors
1 Union Square New York

INSTRUMENT MAKERS

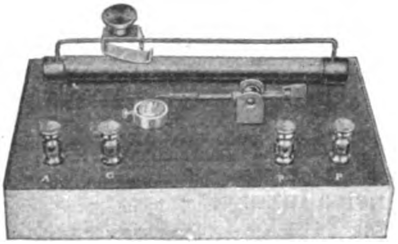
DEPENDABLE TESCO PRODUCTS

SINCE 1909

PRECISION HIGH EFFICIENCY

CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



Without Phones or Aerial

TYPE "A" (Shown in cut) - - **$1.25**
TYPE "B" De Luxe - - **$5.00**

Type A (complete), $6.00 Type B (complete), $11.00

Sent prepaid upon receipt of express or postal money orders.
Money refunded if not absolutely satisfactory.
Dealers and Jobbers write for discounts.

BOYS: You can make good money selling these sets. Write for terms.

THE EASTERN SPECIALTY CO.
3552 N. Fifth Street, PHILADELPHIA, PA.

Radio Dealers!

DO you sell copies of POPULAR RADIO in your store? One dealer sold 150 copies of the May issue in just *two days!* If you are not cashing in on the demand for single copy sales, by all means get in touch with the nearest branch of the American News Company and have them supply you on a *fully returnable* basis.

If you wish further information, write to POPULAR RADIO, Dept. 63, 9 East 40th Street, New York. We'll also tell you how you can make good money taking *subscriptions* to this livest and most practical radio magazine.

The Family Circle Gives You What You Pay For

But the close-up view of an orchestra seat is much better—so it costs more. It is precisely the same with Radio Equipment. *You get what you pay for.*

You can buy a single-circuit receiving set at a much lower cost than you will have to pay for a Paragon three-circuit receiver—but at what a sacrifice of pleasure and satisfaction! Night after night of splendid entertainment simply ruined by mixed messages and general jamming from the hundreds of broadcasting stations.

With a Paragon three-circuit receiver, you can select the radio programme of your choice from the various programmes being broadcasted on any night, get it promptly and hold it from start to finish if you desire. Ask any experienced amateur what he thinks about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Also Manufacturers of PARAGON

Radio Telephone Transmitters
V. T. Control Units
Rheostats
Potentiometers
V. T. Sockets
Detectors
Amplifier Transformers
Control Dials
Amplifiers
Receivers
Switches
Variometers

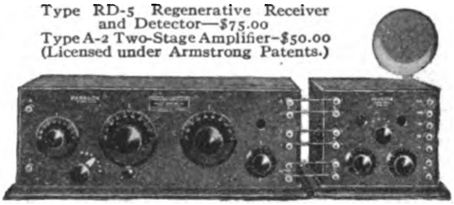
Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An Illustrated Catalog of Paragon Radio Products Is Yours For the Asking

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

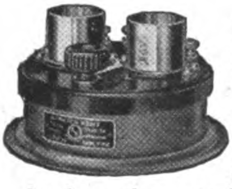
ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)



ATWATER KENT

RECEIVING SETS AND PARTS



If you are now working with a one-tube set, the 2-stage amplifier shown here will give you the necessary volume of sound to make a loud speaker possible.

It is a compact unit — transformers are sealed in the base so that no dampness can affect the working quality of the instrument. To demonstrate the dampproof qualities, one of these instruments was soaked in a tub of water for several hours, then put into a circuit and tested for reception with perfect results.

Send for an illustrated folder showing all parts and complete sets.

ATWATER KENT MFG. COMPANY
4933 Stenton Ave., Philadelphia

In Any or All Stages
of audio frequency amplification

The AMERTRAN

can and should be used.

It is made in only one type and one ratio. Its flat-top amplification curve precludes the possibility of distortion on the part of the transformer when used in any or all stages.

It will give the same clear-toned distortionless amplification with all tubes which are approximately alike in A. C. Impedance and Amplification Factor, such as

WD-11, UV-201-A,
UV-199, C-301-A,
C-301, UV-201.

Price $7
Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

Its amplification in one stage is 38.6; two stages 1490

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

Sidbenel "B" BATTERY
LASTS 5 YEARS

Exceptionally powerful. Makes weak signals strong. A single charge will last six months, recharged (for less than ½c) from any lamp socket or farm lighting generator. Patented high ampere plates charged and formed before leaving the factory.

Positively eliminates battery noises often blamed on static.

Container will not leak and is made of genuine hard rubber. Size 2½" x 3" x 4½".

You assemble the battery easily and pleasurably in less than ten minutes. Complete illustrated directions with each battery.

Large illustrated circular on request.

Price, 22½ volt, unassembled, type S200..... $4.25
assembled, type S200..... 4.65
New type S201-sealed with lugs....... 7.50
Rectifier for A.C.................... .35

Dealers and Jobbers write for proposition
Dept. PR

Sidbenel Radio Equipment Mfg. Co., Inc.
25 W. Mt. Eden Avenue, New York City

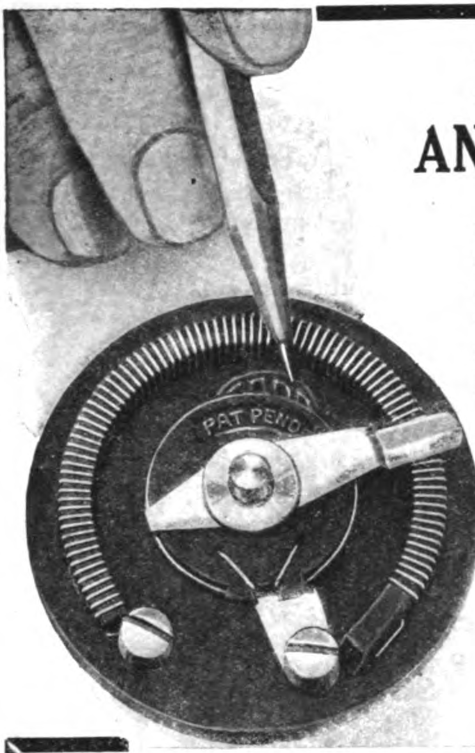
STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO
Published monthly at New York, N. Y., for April 1, 1923.

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kendall Banning, who, having been duly sworn according to law, deposes and says that he is the Editor of POPULAR RADIO, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, POPULAR RADIO, Inc., 9 East 40th St., New York City; Editor, Kendall Banning, 9 East 40th St., New York City; Managing Editor, None; Business Managers, POPULAR RADIO, Inc., 9 East 40th St., New York City. 2. That the owner is: New Fiction Publishing Corporation, 9 East 40th St., New York City, whose stockholders are: Abel I. Smith, 120 Broadway, New York City; Marjorie L. Sargent, Premium Point, New Rochelle, N.Y.; H. B. Emerson, 9 East 40th St., New York City; Metropolitan Finance Corporation, 9 East 40th St., New York City, whose stockholder is Harvey Fisk & Sons, Inc., 34 Pine St., New York, whose stockholders are: Frank B. Ansted, Connersville, Ind.; William G. Audenried, Jr., 34 Pine St., New York City; Harvey Fisk, 34 Pine St., New York City; Pliny Fisk, 34 Pine St., New York City; Lorin L. Homer, 34 Pine St., New York City; Henry K. Hooker, 40 State St., Boston, Mass.; Wilfred Jessup, 34 Pine St., New York City; James Magill, Land Title Bldg., Philadelphia, Pa.; F. O. March, 52 Wall St., New York City; Joseph R. Paul, Westinghouse Bldg., Pittsburgh, Pa.; Carlton W. Rich, 60 State St., Boston, Mass.; Richard U. Sherman, 246 Genesee St., Utica, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) KENDALL BANNING, Editor.

Sworn to and subscribed before me this 31st day of March, 1923.
[SEAL] EUGENE S. BIBB, *Notary Public.*



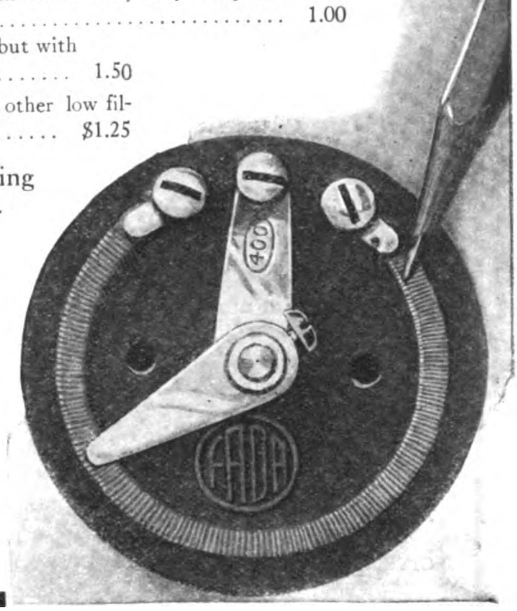
FADA RHEOSTATS AND POTENTIOMETERS

are practically standard with the whole radio industry. It was FADA rheostats in 1921 that were in greatest demand and today FADA rheostats and potentiometers are sold in most every store. Despite imitations, and bootleg radio traffic the FADA trade-mark on rheostats still sets the standard of quality and service.

120-A	5 ohm plain rheostat for all 6 volt tubes	$0.75
121-A	Power Rheostat for three or four tubes in parallel	1.20
150-A	5 ohm vernier Rheostat for best control of 6 volt detector tubes	1.25
151-A	Vernier attachment. Instantly converts almost any 3-16" shaft rheostat into vernier type	.50
152-A	Potentiometer, 200 ohm, for Kaufman, Flewelling, and many other radio frequency amplifier circuits	1.00
153-A	8 ohm rheostat—used for low filament current tubes. Can be converted to vernier type by using the 151-A attachment	1.00
154-A	400 ohm Potentiometer. Has many uses in radio frequency amplifier circuits	1.00
155-A	8 ohm vernier Rheostat—same as No. 153-A but with vernier	1.50
156-A	60 ohm Rheostat for one to four UV—199 or other low filament tubes on either 4 or 6 volt battery	$1.25

FADA products include nearly everything that the radio experimenter needs to construct his own receiving equipment.

The FADA Handbook of Radio Facts and a bulletin describing the new FADA "ONE-SIXTY" receiver with the neutrodyne circuit will be sent for 10c.



F. A. D. ANDREA, INC.

1581-D JEROME AVE. N. Y. C.

32,069 Graves!

Somewhere in Europe there are to-day 32,069 graves of American Soldiers.

Each year since the World War it has been found necessary to raise money to decorate these graves on Memorial Day.

In order to obviate similar annual calls in the future, an Endowment Fund is being created which will insure an annual tribute of flowers on Memorial Day for all time.

Approximately $300,000 is needed. $100,000 has already been raised. The American Legion has pledged itself to raise the remaining $200,000 before May 30th of this year.

Every American should have an interest in this fund and a distinct pride in its purpose. Every donation, no matter how small, will be appreciated.

Our slogan is: "At Least a DIME From Everybody." Make your check payable to

"Graves Endowment Fund"

and mail to

FRANK B. GUEST, 85 West 103d Street, New York City

SPECIAL OFFER

Two new yearly subscriptions to Popular Radio for only . . . . $3.

Rope this Special Offer! Any radio enthusiast can do it. You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both NEW subscribers. You only have to throw a check for $3 around the double coupon and MAIL IT TO-DAY.

(Coupon good until June 20th, 1923)

Popular Radio, Dept. 62,
9 East 40th Street, New York City
Please send Popular Radio for one year to:

NAME.......................................

ADDRESS.................................

CITY.......................STATE.........

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for $3).

NAME.......................................

ADDRESS.................................

CITY....................STATE...........

(*No extra for Canada. Foreign countries 25 cents extra per subscription.*)

Used and Recommended by

Reinartz

TYPE 123-A
.0005 MF (Max)
$4.75
(WITHOUT KNOB AND DIAL)

Throw away your old condensers! When you build the new Cockaday 'Four-Circuit Tuner' you'll need

CARDWELL

"Four-Zero" Variables

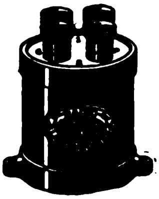
Zero "Body Capacity" Effects
Zero Radio Frequency Losses
Zero Leakage
Zero Maintenance Trouble

A POSTCARD BRINGS YOU AN EDUCATION ON CONDENSERS
ASK FOR BOOKLET D

The Allen D. Cardwell Mfg. Corp'n
85 PROSPECT ST. BROOKLYN, N. Y.
Designers of Standard Radio Instruments
CARDWELL Products are used All Over the World

THE NEW RT-8

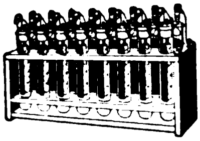
Radio Frequency Transformers are specially designed by the **Radio Service LABORATORIES** for maximum efficiency when used with any low current consumption tubes on the market.



For Audio Frequency, the new RT-A2 will give you 100% Tone Quality and High Amplification without distortion. For best results on both tone and distance, use Radio Frequency RT-8 (for all stages) in the black case, retail price $6.00, and Audio Frequency RT-A2 in brown case, retail price $6.50. For sale at all reliable electrical or **Radio** Stores. If your dealer cannot supply you, order direct. Order by type number, accept no substitute, and remember that all **Radio Service Laboratories'** Transformers are individually triple tested and unconditionally guaranteed.

Send ten cents for booklet on Radio Frequency with schematic diagrams—a most valuable and helpful publication for the radio amateur and expert.

RASLA SALES CORPORATION
National Distributors
DEPT. P, 10 E. 43rd ST. NEW YORK CITY



$4.00, complete, 22½ Volts

Renewal $2.50

Cheaper than a "B" storage battery and requires no attention

No corrosive or dangerous liquids

The Carbon Giant "B" Battery

Guanteed for One Year
Each Renewal Guaranteed for One Year

This battery is similar in principle and voltage to the ordinary dry "B" battery. It contains enough water, however, to complete the chemical reactions involved and therefore it is far more efficient and will give longer life in proportion to its size than batteries of the dry type.

Best for high voltage loudspeaker installations. Best for ordinary broadcast reception. Best for DX.

Remittances should include parcel post charges on 7 pounds. Circular on request. Dealers and agents, please write.

The Copper Giant Battery Co., Lansdowne, Pa.

RADIO FREQUENCY AMPLIFICATION

Get the best results with radiophone reception. Long distance reception, purity and volume of tone reproduction, static reduction, and selectivity. We have working plans, blue prints, with exact specifications of parts to assemble to construct a three tube set. Gives marvelous results. Save worry and experimentation in building one of these sets. Any amateur can build. Guaranteed results. Sent for $1.00 postpaid.

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Will be Good

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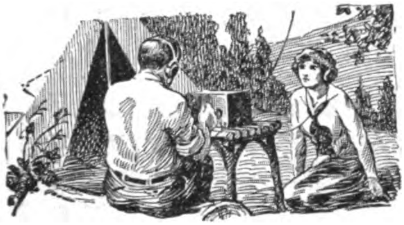
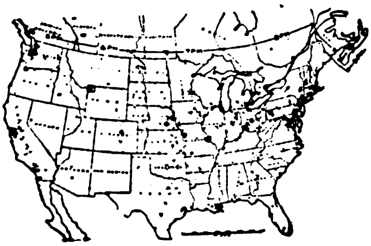


1 Perfection of portable receiving sets now makes possible their use outdoors. You can dance, "spoon" and listen to good radio music, on your camping trip, boating cruise, or automobile tour.



2 There are plenty of good broadcasting stations now all over the country. No place in the United States is farther than 150 miles from a good broadcasting station, and at that distance "static" cannot interfere with good reception.

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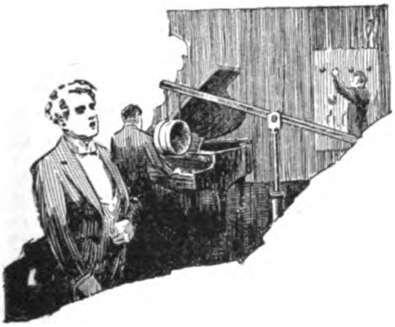

3 Improvements in transmission equipment and methods of sending, together with better quality and more frequent broadcasting, insures better reception and a more enjoyable program at all times.

4 Here is the foundation on which to build your radio enjoyment. The Lefax Radio Handbook will start you right and keep you that way. It is written by the two chiefs of the Radio Department, U. S. Bureau of Standards. It is a loose leaf pocket-size book, bound in beautiful imitation black morocco leather. Lefax Radio Handbook never grows old. A monthly service called "Radiofax" keeps perpetually up to date. Lefax Radio Handbooks are sold by leading radio dealers and stationers. Price $3.50 including Radiofax for one year.

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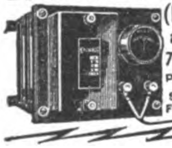

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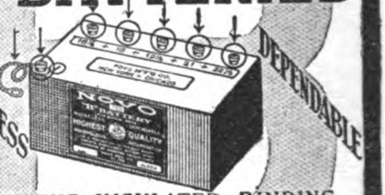

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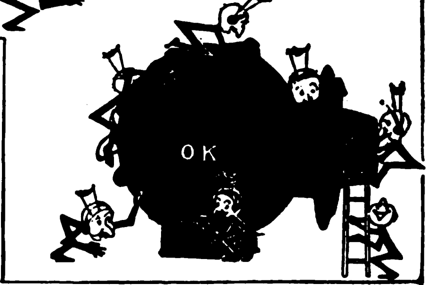

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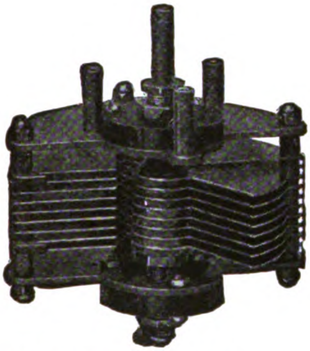

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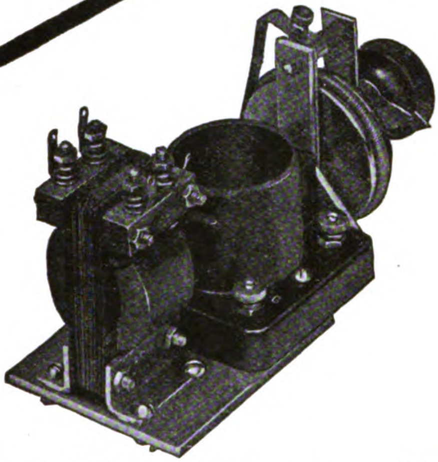

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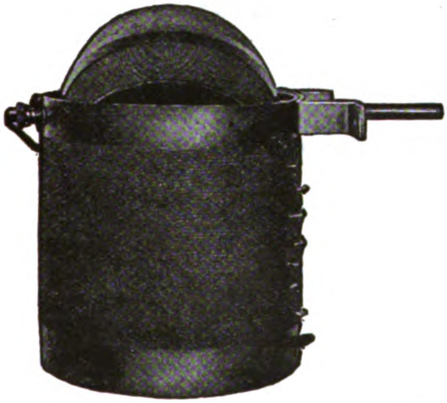

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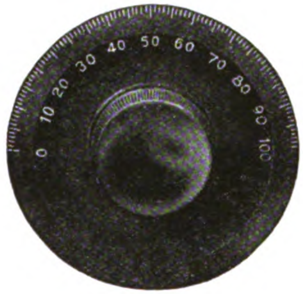

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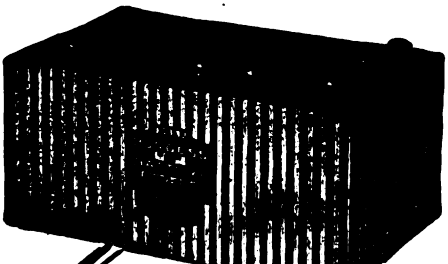

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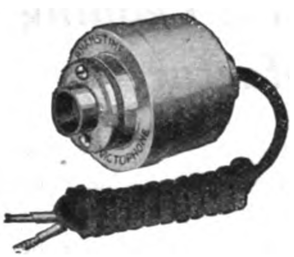

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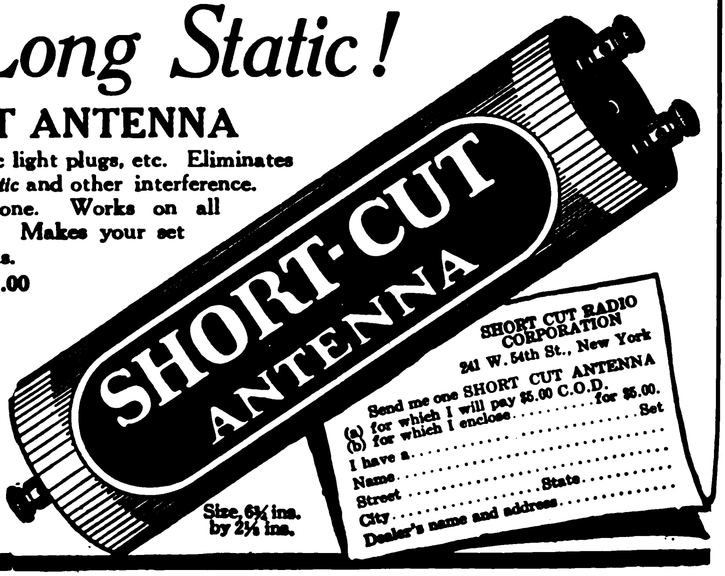

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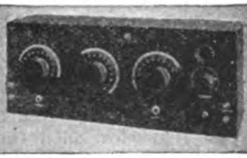

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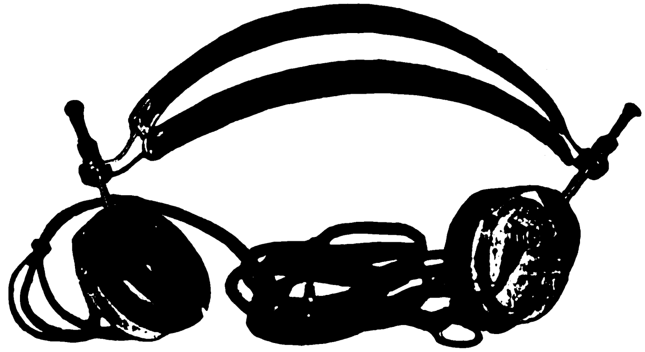
Teleradio

(TRADE-MARK)



SUPER SENSITIVE PHONE

USED IN EVERY STATE IN THE UNION

are the result of years of experience in the construction of delicate electrical apparatus.

They are designed and built on sound engineering principles. They are famous for their super sensitiveness, superior quality of tone, volume, and clearness—accurately reproducing either vocal or musical sounds with wonderful tonal qualities. *Equally satisfactory for local or long distance work.*

Growing popularity — INCREASING SALES prove it is the PERFORMANCE and SATISFACTION of TELERADIO *correctly balanced* Phones that really count.

TRY THEM AND BE CONVINCED

Type C, 2000 ohms, **$6.50**: Type B, 2200 ohms, **$7.50**; Type A, 3000 ohms, **$9.00.**

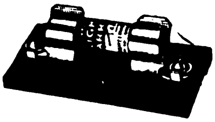
TELERADIO FILAMENT RHEOSTAT

Can be mounted on panel or table

Will carry 1½ amps without overheating and is wound to 6 ohms resistance

Price, **$1.00**

TELERADIO LIGHTNING ARRESTER

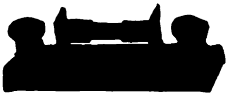


Electrical No. 5837

Approved by the National Board of Fire Underwriters

Price, **$1.00**

TELERADIO FILAMENT PROTECTOR



For detector and amplifying tubes

Complete, **60c**

Extra fuses, **10c** each

OTHER TELERADIO "HIGH QUALITY" PRODUCTS

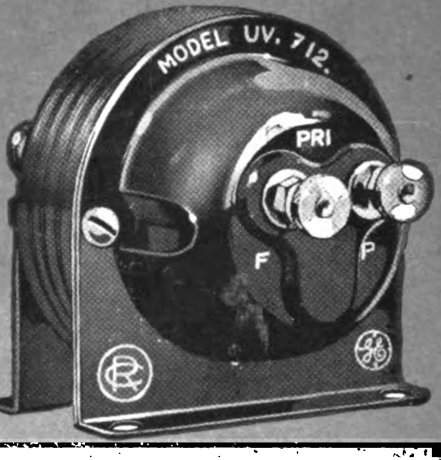
Variable Condensers, 3-11-23 and 43 plates, **$1.50, $2.50, $3.00** and **$4.00,** respectively. Tube Sockets, **60c;** Fixed Phone and Grid Condensers, **35c** each; Grid Leak Condensers, **50c** each.

Jobbers and Dealers write for our attractive proposition

TELERADIO ENGINEERING CORPORATION

484–490 BROOME STREET, NEW YORK CITY

PRESS OF WILLIAM GREEN, NEW YORK



Transformer
UV-712
$6.50

Volume — undist[illegible]ed!

With Audio-Frequency Transform[illegible]V-712

- —Complete shielding to preve[illegible] interaction between fields.
- —Sturdy build to withsta[illegible] rough use and much handlin[illegible]
- —Exact construction to elimi[illegible]nate distortion in each stag[illegible] of amplification.
- —Special care to minimize transformer losses, thus giving unequalled volume.

This symbol of quality is your protection

Particularly Designed for Use With RCA Radiotrons

Radio Corporatio[illegible]
of America

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